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FOURTH ANNUAL MEETING

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CONSTITUTION.

ARTICLE I.

Name: This society shall be known as the American Rœntgen Ray Society.

ARTICLE II.

Object: The object of the Society shall be the study and practical application of the Rœntgen Rays.

ARTICLE III.

Section 1. Its members shall be active, corresponding and honorary, and shall be persons interested in the object of the Society, recommended by at least two members, in writing, and approved by the Executive Committee, who must have proof of their good ethical standing. They shall be elected by ballot.

Section 2. Active members shall be residents of America, shall sign the Constitution and pay annual dues of five dollars ($5.00).

Section 3. No member who is in arrears for annual dues shall vote or hold office. Any member in arrears for more than two years, and duly notified by the Treasurer by registered letter, shall forfeit membership.

Section 4. Corresponding members shall be residents of foreign countries.

Section 5. Honorary members shall be persons who have distinguished themselves in Rœntgen Ray research or practical work.

Section 6. Corresponding and honorary members shall have all the privileges of active members except voting and holding office.

ARTICLE IV.

Officers: The officers shall be a President, five Vice Presidents, a Secretary, a Treasurer and an Executive Committee of three. The officers shall be elected annually by ballot.

ARTICLE V.

Duties of Officers.

Section 1. The President shall perform all the duties pertaining to that office, and shall deliver an address during the annual meeting.

Section 2. In the absence of the President, one of the Vice Presidents shall preside.

Section 3. The Secretary shall keep, or cause to be kept, a correct record of all transactions of the Society in a permanent form. He shall send due notice of all meetings to each member, shall notify all members of committees of their appointment and of the duties assigned to them. He shall conduct the correspondence and perform all duties usually pertaining to his office.

The Secretary shall have printed an alphabetically arranged list of the members of the Society, with their addresses, for free distribution to members applying for same. This list shall be revised from time to time, and shall specify charter members.

Section 4. The Treasurer shall receive and be accountable for all money that shall come into his hands by virtue of his office. He shall give good and sufficient bond to the Executive Committee for the safe keeping and disposal of his trust, and shall make a full report to the Society annually. He shall pay out money only by the written approval of the President and Chairman of the Executive Committee.

Section 5. An Executive Committee of three members shall be elected as follows: One for three years, one for two years, and one for one year; thereafter one annually to serve three years. They shall hold the bond of the Treasurer, audit his accounts annually, arrange for annual meetings, and have general supervision of the affairs of the Society not otherwise provided for.

Article VI.

Meetings: The annual meeting shall be held on the Wednesday following the second Tuesday of December of each year, unless otherwise arranged by the Executive Committee.

Article VII.

A Committee on Publication consisting of five members, of which the President and Secretary shall be members, shall be appointed annually, by the President.

Article VIII.

This Constitution may be amended by a three-fourths vote of all the members present at an annual meeting, provided the proposed amendment has been read before the Society at least one day previously, and the hour for action has been set by the Society and announced in the open meetings for at least one day previously.

BY-LAWS.

1. A Nominating Committee of three shall be appointed by the President on the first day of meeting. Said committee shall make report on the second day of meeting.

2. The newly elected officers shall take office at the close of the last day of the meeting at which they are elected.

3. All matters of parliamentary usage, not already provided for, shall be decided according to Roberts' Rules of Order.

4. Essays designed for the program must be submitted, in whole or in part as requested by the committee, to the Executive Committee at least two months before the time of meeting of the Society.

5. Papers shall be limited in reading to twenty minutes. Openers of discussion shall be allowed ten minutes and all others five minutes. No person shall speak twice on the same subject, except by permission of the meeting.

6. A member found guilty of reprehensible conduct may be expelled from the Society on recommendation of the Executive Committee, and by a two-thirds vote of members present.

7. The order of business shall be:

(1.) Call to order.
(2.) Reading of minutes.
(3.) Unfinished business.
(4.) Report of committees.
(5.) Election of members.
(6.) New business.
(7.) Announcement of Nominating Committee by the President, or report of same to the Society.
(8.) Reading of essays.

MINUTES OF THE FOURTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY.

The fourth annual meeting of the American Roentgen Ray Society was held at the University of Pennsylvania, in Philadelphia, on December 9th and 10th, 1903, President Arthur W. Goodspeed occupying the chair.

December 9th. Morning session.

Dr. Marsh, chairman of the Executive Committee, made report of that committee, and moved to extend courtesy of the floor to members of the Philadelphia medical societies.

Dr. Pancoast, chairman of the Local Committee of Arrangements, made report, this being followed by reports of Secretary and Treasurer.

New members were then elected. (A list of new members elected at this meeting is appended, alphabetically arranged, to these minutes.) Captain D. C. Howard, representing the army, and Department Surgeon Fairfax Irwin, representing the Public Health and Marine Hospital Service, were announced as delegates. The reading of essays was then taken up in the following order:

1. Newcomet.
2. Leonard.
3. Skinner.

Afternoon session, December 9th. Reading of essays.

4. Hulst.
5. Kassabian.

In the evening President Goodspeed made the annual address.

Morning session, December 10th.

Motion made by Dr. Price to discharge old Committee on Standards and then to appoint new committee. Amendment offered by Dr. Bullitt that Dr. Goodspeed be made chairman of this committee, and that he be empowered to appoint as many on the committee as he may see fit. Carried.

The President announced the following appointment on the Publication Committee: Johnston, of Pittsburg; Pancoast, of Philadelphia; Dunham, of Cincinnati.

The reading of essays was then taken up, as follows:

6. Hickey.
7. Dunham.
8. Price.

The Nominating Committee, R. F. Girdwood, Chairman, reported the following announcements: For President, James B. Bullitt, Louisville; for Treasurer, Weston A. Price, Cleveland; for Secretary, Russell H. Boggs, Pittsburg; for Vice-Presidents, J. B. Murphy, Chicago; Roswell Par, Buffalo; Charles Lester Leonard, Philadelphia; Edward E. King, Toronto. Executive Committee: P. M. Hickey, Detroit, and Kennon Dunham, Cincinnati, Ohio.

On motion, a vote of thanks was tendered to the University of Pennsylvania and its various officers for various courtesies extended to the American Roentgen Ray Society.

It was moved that suggestion be made to the Executive Committee that work for the coming year be directed along developed-mental skiagraphic lines.

Afternoon session, December 10th. Reading of essays.

9. Burdick.
10. Pancoast.
11. Hopkins.
12. Wilbert.

Evening session, December 10th.

Motion made by Dr. Marsh that members reading papers before the American Roentgen Ray Society may publish them whenever they see fit, allowing due credit to this Society and leaving a copy of the paper with the Secretary.

Reading of essays.

13. Boggs.
14. Pancoast.
15. Pitkin.

Motion made by Dr. Bullitt that papers of Caldwell and Scott be read by title.

Adjournment.

ANNUAL REPORT OF THE SECRETARY OF THE AMERICAN ROENTGEN RAY SOCIETY.

The Secretary's work for the past year has been concerned chiefly with the issuance of the Volume of Transactions and with efforts to further increase the membership of the Society.

The Volume of Transactions was gotten out at a considerable cost of time and labor on the part of the Secretary; this was owing to the fact that the Publication Committee, while most willing to render all assistance possible, was so widely scattered geographically as to make it necessary for the Secretary to do all the work in this connection, and to assume the responsibility which should otherwise have been divided. The issue consisted of 1,500 volumes, of which 500 were bound in cloth and 1,000 volumes in paper covers; the total cost of these, together with such reprints as were ordered for individual members, was $611.64. Against this there was a credit for advertisements in the back of the volume, sale of volume in paper covers to advertisers, and reimbursements for reprints, amounting in all to $243.45. So that the net expense for the volume was $368.19, which includes the cost of placing the volume in the hands of the members.

Of the remaining volumes 73 copies were sent to various medical publications for review, and 33 copies were sent to medical libraries. The remainder of the copies, with the exception of a few which still remain on hand, have been used for the purpose of interesting in the work of the Society possible applicants for membership. This work, with the assistance of many members of the Society all over the country, has resulted in 37 applications for membership since the last annual meeting in Chicago. At the close of our last annual meeting our membership was 222; with these 37 approved applications the total is brought up to 259.

All bills which have been contracted by the Secretary have been paid by check by the Treasurer on demand by voucher, which has first received the signature of the President of the Society and the chairman of the Executive Committee, and all receipts for money paid are held by the Treasurer of the Society and will be accounted for by him in his report.

In conclusion the Secretary desires to call the attention of the members to the fact that the arrangements for the present annual meeting and the excellent program which has been secured, are entirely due to the arduous and efficient efforts of Dr. James P. Marsh, chairman of the Executive Committee, and Dr. Henry K. Pancoast, chairman of the Local Committee of Arrangements, to whom the Society owes its thanks.

After much correspondence, arrangements have been made with the various passenger associations, with the exception of the Southern and South-Western, for a one and one-third fare rate on the certificate plan. In order that this rate may be effective it is necessary that at least one hundred tickets shall have been purchased for a fare of at least seventy-five cents. Members are therefore requested to register their names and addresses in the book provided for the purpose and to leave their tickets at the Secretary's desk. As soon as the requisite number has been deposited they will be validated by the railroad representative and will then be returned to the respective owners.

ANNUAL REPORT OF TREASURER.

Cash Account of American Rœntgen Ray Society, December 7, 1903.

RECEIPTS.

1902.			
Dec. 10 and 11.		Dues received during Chicago meeting	$ 550.00
Dec.	11.	Exhibits of Chicago meeting	367.00
1903.			
Jan.	13.	Ex-Treasurer, Dr. Florentine	89.85
Dues received from Dec. 11, 1902-Dec. 7, 1903			236.18
From advertisements in and sale of Transactions and Reprints			243.70
Total receipts since Dec. 10, 1902			$1,496.73

DISBURSEMENTS.

Expenses of Chicago meeting:				
		Sherman House	$ 200.60	
		Mr. Zapfee, stenographer	88.00	
		Whitehead & Hoag, buttons	7.50	
1902.				
Dec.	11.	Accumulated bills for printing and postage for previous year	112.05	
Dec.	20.	Fidelity & Casualty bond	10.00	
1903.				
June		Cost of publication of Transactions	611.64	
Dec.	7.	Returned fees to date	25.00	
		Total		$1,054.79

PRINTING BILLS.

1903.				
March	12.	F. C. Nunemacher	$ 5.96	
March	25.	S. Barker & Sons	9.10	
June	5.	S. Barker & Sons	5.80	
July	25.	F. C. Nunemacher	3.90	
Oct.	15.	Courier Journal Job Printing Co.	12.50	
Oct.	15.	F. C. Nunemacher	16.50	
Nov.	17.	Dr. Hickey	8.25	
Nov.	19.	F. C. Nunemacher	23.25	
Oct.	15.	Dr. J. B. Bullitt (stenographic work and postage)	20.20	
Dec.	7.	Total disbursements since Dec. 10, 1902	$1,160.25	
Dec.	7.	Cash in bank	336.48	
		Total		$1,496.73

WESTON A. PRICE, *Treasurer.*

PROGRAM.

1. President's Address: The Trend of Modern Thought Upon the Sub-Atomic Structure of Matter; by Prof. Arthur W. Goodspeed, Ph.D., Philadelphia, Pa.

2. Pathologic Changes in Tissue Under the Influence of the X-Ray; by William S. Newcomet, M.D., Philadelphia, Pa. Discussion to be opened by Seabury W. Allen, M.D., Boston, Mass.

3. The Results of the Rœntgen Method in the Diagnosis of Renal Calculus; by Charles Lester Leonard, M.D., Philadelphia, Pa. Discussion to be opened by James B. Bullitt, M.D., Louisville, Ky.

4. Two Cases of Severe X-Ray Necrosis, Presenting Some Unusual Features; by Clarence Edward Skinner, M.D., New Haven, Conn. Discussion to be opened by J. N. Scott, M.D., Kansas City, Mo.

5. Localization of Foreign Bodies by the Rœntgen Rays; by William E. Sweet, M.D., Philadelphia, Pa. Discussion to be opened by J. Cajetan Flynn, M.D., Philadelphia, Pa.

6. Skiagraphy of the Chest; by Henry Hulst, M.D., Grand Rapids, Mich.

7. How to Obtain an Instantaneous Skiagraph of the Thorax; by Mihran K. Kassabian, M.D., Philadelphia, Pa. Discussion upon the above two papers to be opened by Gordon G. Burdick, M.D., Chicago, Ill.

8. Care of the Static Machine; by Henry E. Waite, M.D., New York. Discussion to be opened by Walter W. Johnson, M.D., Rochester, N. Y.

9. The Development of the Skeleton, Radiographically Considered (Lantern Slides); by Preston M. Hickey, M.D., Detroit, Mich. Discussion to be opened by G. P. Girdwood, M.D., Montreal, Canada.

10. The Effects of Rays Upon Lower Animal Life; by Kennon Dunham, M.D., Cincinnati, Ohio.

11. Technique For Making Good Dental Skiagraphs; by Weston A. Price, D.D.S., Cleveland, Ohio. Discussion to be opened by Levitt E. Custer, D.D.S., Dayton, Ohio.

12. The Therapeutic Effects of the X-Rays, as Shown from the Results of Treatment of One Hundred Cases; by Henry K. Pancoast, M.D., Harvey Bartle, M.D., and Mr. Henry C. Welker, Philadelphia, Pa. Discussion to be opened by Emil H. Grubbe, M.D., Chicago, Ill.

13. Treatment of Lupus and Epithelioma by the Combined Use of the X-Rays and Ultra-Violet Light; by J. N. Scott, M.D., Kansas City, Mo. Discussion to be opened by George G. Hopkins, M.D., Brooklyn, N. Y.

14. A comparative Study of Fractures of the Extremities; by Martin I. Wilbert, M.D., Philadelphia, Pa. Discussion to be opened by Russell H. Boggs, M.D., Pittsburg, Pa.

15. Developers; by Gordon G. Burdick, M.D., Chicago, Ill. Discussion to be opened by Mihran K. Kassabian, M.D., Philadelphia, Pa.

16. Accuracy in X-Ray Diagnosis; by Russell H. Boggs, M.D., Pittsburg, Pa. Discussion to be opened by J. D. Gibson, M.D., Birmingham, Ala.

17. Exploding Tubes; by Henry K. Pancoast, M.D., Philadelphia, Pa. Discussion to be opened by William Jordan Taylor, M.D., Cincinnati, O.

18. Dangers to the X-Ray Operator; by John T. Pitkin, M.D., Philadelphia, Pa. Discussion to be opened by Weston A. Price, D.D.S., Cleveland, O.

THE TREND OF MODERN THOUGHT ON THE SUB-ATOMIC STRUCTURE OF MATTER.

BY ARTHUR W. GOODSPEED, PH.D.,
Of Philadelphia, Pa.

Professor of Physics at the University of Pennsylvania (Randal Morgan Laboratory of Physics), President of the American Rœntgen Ray Society, etc.

Mr. Provost of the University of Pennsylvania—I have the honor, on behalf of the American Rœntgen Ray Society, as its president, to express to you our great appreciation of the cordial attitude assumed by you a year ago when approached as to the advisability of exerting my influence to bring our society to Philadelphia for its next meeting.

The result has been that not only are we holding our fourth annual convention in this city, but also under the fostering influence of this great center of learning, and the effeet must surely be beneficial to our society.

Fellow members of the American Rœntgen Ray Society—as representing, myself, one of the important scientific departments of this university, the third oldest in the country as a college, but the very oldest as a real university, I welcome you most cordially, feeling sure that the result of this meeting will add much to the credit and renown of our institution.

For my address this evening I am prepared to outline in simple language the present attitude of science toward electricity and its relation to matter, and I suggest as a title "The Trend of Modern Thought on the Sub-Atomic Structure of Matter." It will, of course, be quite impossible in the time at my disposal to give the lines of reasoning or the methods of investigation which have led up to the present-day conclusions provisionally accepted in physical science. Those wishing to study the subject more in detail will find of use the partial bibliography which I append. Most prominent among the large number of authorities whose work furnishes strong evidence in favor of the views here to be set forth are Crookes,

Kelvin, Rutherford and J. J. Thomson. Especially fortunate am I in having access to some excellent notes, taken by my colleague, Dr. H. C. Richards, on the lectures given by Thomson last spring at Baltimore.

Not very long ago it was the custom of teachers of physical science boldly to assert that matter and energy together comprised every conceivable existence in the physical world. Electricity and the aether, however, presented difficulties to this brief classification, though it was often predicted that at some time and somehow electricity would be shown to be a connecting link between aether and matter. To what extent this expectation has been realized will be apparent when we have taken a brief survey of the evidence about to be presented.

Tait in his charming little book on "The Properties of Matter" illustrates the "objectivity of energy" by saying that it is ever being offered "for sale" or "for let." But surely accepting such an argument would imply far too much now in America. Indeed, the "objectivity of *space*" would be proved beyond a doubt if we contemplate the success of our executive committee in selling to exhibitors the space on the floor below. However, the same author admits later on that "to have its price" is not conclusive of objectivity, citing as evidence that titles, family secrets and even college degrees are sometimes sold.

On first thought it would seem far easier to study matter than to study energy, and this is so perhaps if one does not proceed farther than to analyze and to classify the properties of bodies having tangible and visible size. We can, for example, find out nearly all there is to know about a certain piece of glass, considered only as a mass of glass of definite size and shape. We can measure its mass correctly to one part in ten million; its linear dimensions correctly to one one-hundred-thousandth of a centimeter; its density; its elasticity; refractive index; dispersive power, etc., etc., all to a high degree of accuracy. Suppose now we have made a similar physical examination of a definite piece of quartz; at once is suggested, Why this difference in properties? They must be due to differences in the finer structure of the substances not apparent by the grosser methods of examination. Chemistry now steps

in with its beautiful analytic methods and classifies the many substances or kinds of matter composing bodies.

At any particular time in the history of science, say on January 1, 1900, any well-informed chemist would have told us that all substances are either elementary or compound, the number of the former class being definite, say seventy, while the number of compounds is far greater and less definite. At almost any subsequent date the number of elements would be stated as larger; indeed, in answer to the direct question put recently to our professor of chemistry, Vice-Provost Smith, I was told that the accepted number is now about seventy-five. This increase from time to time results from the dividing of a supposed element into two, or from the discovery of a new one, all the old ones remaining intact. The separation of didymium a few years ago into its neo- and praseo-constituents is an example of the former method, while the latter has been exemplified more recently by the discovery of several unsuspected constituents of the atmosphere—viz., the inert gases of the argon group.

Until rather recent years physics was said to treat of masses and of molecules and their energy relations, while chemistry investigated molecules and atoms and their energy relations. More recently physics and chemistry together, aided by that ever-powerful ally mathematics, have strenuously attacked the atom, hoping through this doorway—narrow, it is true, but manifold—to flash now and then a ray of light illuminating for a moment, if but dimly, the mysteries beyond.

The advances in physical science during the last century have been many and rapid, yet made with such care, each new discovery or generalization being criticised so severely and impartially, that what has stood all tests and finally been generally accepted forms a most stable and reliant structure to which very recently the trial framework of another story has been erected

From the various experiments described by Crookes in 1879, he was convinced that the residual gas in a very high vacuum under the action of an electric discharge presents properties so different from those of ordinary gas as to warrant the application of the title "radiant matter," to what we now us-

ually call cathode rays or Crookes rays. Crookes himself insisted that the cathode rays must consist of rectilinear streams of negatively electrified molecules projected with high speed from the cathode. The beautiful mechanical devices which he invented to demonstrate the probability of this view are quite familiar and it is not necessary to describe them here. Although Crookes' conclusions were not then accepted by everybody, later developments have shown them to be in the main correct, except as to the magnitude of the bodies concerned.

In 1895 Perrin proved this by actual experiment, and later also J. J. Thomson by a different method.

By a simple though ingenious line of reasoning, based upon well-known principles of dynamics, Thomson was able to measure the speed, the mass and the electric charge of these little bodies. It had been shown by Crookes that the cathode stream is easily deviated both by a magnetic field and by an electrical one. If the direction of the magnetic field be perpendicular to the motion, the deviating force is Hev in which H is the intensity of the field, e the charge in each body, and v the speed. But under these conditions the paths of the particles are circular, as would result from a central force $\frac{mv^2}{r}$ m being the mass of each particle and r the radius of the circular orbit. Equating the above, it follows that $(\frac{e}{M}) = \frac{v}{Hr}$

Now H and r can be measured by obvious methods, but the value of v had to be obtained in order to calculate the value of the ratio of charge to mass. This was done by Thomson by introducing an electrical field perpendicular to both the direction of motion and to the magnetic field. The strength of this electrical field was so adjusted as to straighten again the circular paths of the particles. This gave the equation,

$$Fe = Hev \text{ or } v = \frac{F}{H}$$

In Thomson's experiments the values obtained for v were between 2.2 and 3.6 times 10^9 c. m. per second, or about one-tenth that of light.

V depends somewhat on the degree of exhaustion on account of the interference of intermediate impacts. The value

of $\frac{e}{m}$ from these data is about 10^{7} C. G. S. units, or the mass required to carry a unit of electricity is 10^{7} of a gram. As the value of $\frac{e}{m}$ is found to be independent of the kind of gas filling the tube before exhaustion, and also of the substance of the electrodes, one is forced to the conclusion that these little carriers, "or corpuscles" as Thomson calls them, must be quite a strange form of matter and not at all identical with either a molecule or an atom, though forming a part, always the same in kind, of atoms of all kinds.

Since it has been shown that the charge on a particle in gas electrolysis has the same value as that conveyed by a hydrogen atom in liquid electrolysis—viz., 1.13×10^{-20} E. M. U.; and since 10 of a gram of hydrogen carries a unit charge in liquid electrolysis, it follows that each corpuscle must have a mass equal to 10^{-3} of that of a hydrogen atom, or about 2.3×10^{-27} of a gram. In other words, the atom of the chemist and of the physicist, conceived of 2,400 years ago by Demokritus and Leukippus, and glorified, as Tait puts it, in the grand poem of Leucretius; of the chemist as the smallest portion of matter capable of forming part of a compound substance, of the physicist as the smallest part that can receive or give an impulse or take part in an energy change, has been shown in the last decade or less to be 1,000 times more massive than a "corpuscle," and this, too, though we choose the least atom known, that of hydrogen.

Lenard in 1893 was able to get the cathode rays outside the vacuum tube through a very small aluminum window. He thereby studied their properties, which have since become well known.

Three years later Rœntgen discovered other rays, the properties and effects of which have been studied ever since all over the world and which have become of vital importance in more than one department of science. Everybody present is more or less familiar with these rays and I have no intention before this audience certainly of telling the oft-told story. "What are they?" as well as, "What do they?" should be the question of the physicist. They differ from cathode rays in not being easily deviable by either a magnetic or by an elec-

trical field. They are unlike light rays in not being susceptible either of reflection, refraction or polarization within the usual meanings of these terms.

Other rays having some properties in common with those of the cathode rays and the Rœntgen rays were discovered in 1896 by Becquerel to be given off by the double salt of uranium and potassium. These uranium emanations have excited much interest ever since and been carefully studied by Becquerel and others with many startling results.

In 1898 Mme. Curie, having taken up the study of the various salts of uranium, and then of the various minerals containing uranium, announced through Prof. Becquerel her results. Her first important conclusions were that the salts were active in proportion to the uranium in them, but that the minerals were not so.

For example, uranium, or pitchblend as it is called, was found to be several times as active as metallic uranium itself; hence uranium cannot be the chief agent in the production of the emanations.

After a long and most careful chemical research Mme. Curie, assisted by her husband, separated from a very large amount of uraninite a very small quantity of an active substance similar to bismuth, which seemed to be a new element. They called this polonium, from Poland, their native country.

Continuing their work with vigor, the Curies soon announced the separation of still another elementary substance from uraninite with a radio-activity 10^5 times as great as that from metallic uranium. This was called radium. The rapidly increasing popular as well as scientific interest in this wonderful substance would justify the time and space necessary to relate some of its properties, even if it did not furnish a very suitable example for illustrating the latest theory of matter to be spoken of presently. The quantity obtainable from uraninite, so far the most fruitful source is exceedingly small. It is estimated that to obtain a single pound, and that not pure, would require the working of 5,000 tons of the mineral. Chemically radium is closely allied to barium.

A third radio-active substance which was allied to iron was discovered by Debierne in 1899; this he called actinium.

The status of actinium as an element I believe is questioned. The emanations from all these substances are similar, and the superb research work of the Curies, J. J. Thomson, Rutherford, Crookes, Kaufman and many others probably whose names should with equal justice be mentioned has resulted in much new science and in throwing some light on the mysterious problems yet to be solved. Without going at all into the details of the methods of investigation, let me say briefly that it is found that the emanations from radium are of three kinds. Rutherford designates them, first, α -rays, positively electrified particles, very feebly penetrating and only very slightly deviable in the strongest fields and having a mass of the same order of magnitude as that of an atom; second, β-rays, identical with the Crookes or cathode rays—i. e., negatively charged particles, to which he gives the special name "corpuscles," somewhat penetrating, deflectable by both a magnetic and an electrical field, third, γ-rays, identical with the Rœntgen rays, very penetrating and practically non-deviable.

I propose now briefly to outline the electrical theory of matter and to show how it may be interpreted to explain not only many of the long known facts, but also some of the recently discovered phenomena the nature and cause of which have not been agreed upon.

If a body of mass m move with a speed v, its kinetic energy is given by the simple formula,

$$E_k = \frac{1}{2} m v^2$$

This, of course, is equal to the work required to give the mass m speed v. If now the body, assumed spherical for simplicity, have an electrical charge, a magnetic field is produced simultaneously with the motion and more work will be required to produce the same speed in m. It can be proved mathematically that this *extra* work required to produce the magnetic field is

$$\frac{1}{8} \frac{e^2}{a} v^2$$

in which e is the charge, a the radius of the moving sphere and v the speed.

Adding the magnetic energy thus developed in the aether to the mass energy, the total becomes,

$$E = \frac{1}{2}\left\{m + \frac{2}{3}\frac{e^2}{a}\right\}v^2$$

in which the quantity in brackets becomes the effective mass or the real inertia of the combination, and $\frac{2}{3}\frac{e^2}{a}$ the electric inertia. Now as the sphere when charged controls more energy than when not charged, the aether must have supplied the extra, and be ready to absorb it as the body comes to rest.

Now let us take quite another attitude and adopt Faraday's conception of tubes of force and endow these tubes with momentum. Assuming again the same conditions, we can prove mathematically that the electric momentum due to the moving charge e would be

$$\frac{2}{3}\frac{e^2}{a}v,$$

which gives the same value as before for the electric inertia, viz., $\frac{2}{3}\frac{e^2}{a}$.

Mental help would be derived in thinking of these phenomena by noting the sensation experienced in pulling a body through a limpid liquid like water. Mathematical analysis proves that the apparent mass of a sphere is increased by one-half the liquid mass displaced. We use mass always in the sense of inertia. This effect is independent of direction of the motion because of the symmetry of the spherical form. If, however, a long cylinder be propelled in a liquid the external inertia will clearly be a function of the direction of the motion relative to the longest or shortest dimensions of the cylinder. If the motion be parallel to the axis of the cylinder, a small liquid displacement per unit distance of motion will result; while if the movement be at right angles to the axis the maximum external inertia is produced. Further, if an *infinite* cylinder in a liquid (e. g., a tube of force in the aether) be moved in any direction (except longitudinally, which means that it is not moved at all), it has external momentum only at right angles to its length. The energy of a tube we conceive as belonging to the body from which the tube originates, the inertia being due to the grip of these force tubes on the aether (to use an expression of J. J. Thomson).

In the discussion resulting in the conclusion that the electrical mass of a charged body in motion is proportional to $\frac{e^2}{a}$ the speed was supposed small in comparison to that of aether wave-motion. In the case of a corpuscle having a velocity of the same order of magnitude as that of light a further analysis is necessary. In this case the electrical mass will depend on the speed. A contemplation of Doeppler's principle will make this evident, since as the charge changes position there is a continuous though not instantaneous readjustment of the lines of force which would radiate in all directions in straight paths if the charge were at rest. When the speed of the charged sphere has reached that of aether wave-motion, the force tubes would be all equatorial and the mass infinite.

If, then, it could be shown *experimentally* that the effective mass of a moving charged body is dependent on its speed, a part at least of this mass would have to be electrical, and due to this force-tube inertia. The experimental test of the question was made by Kaufmann when he measured the ratio $\frac{e}{m}$ in the case of the negative carriers (i. e., the β-rays) from radium. These rays have a higher average speed than cathode rays and in Kaufmann's experiment rays of different speeds were measured. The ratio $\frac{e}{m}$ varied from $(1.31 \text{ to } 0.63)\times 10^7$ according to the speed of the corpuscles.

Now Thomson, in his "Recent Researches," develops a formula for the electrical momentum of a charged body without any limitation to the speed:

$$I = \frac{e^2}{2a\sqrt{\ }} \frac{V^2}{V^2 - v^2}\left\{\theta\left(1 - \frac{1}{4}\frac{V^2}{v^2} - \frac{1}{2}\sin 2\theta\left(1 + \frac{1}{4}\frac{V^2}{v^2}\cos 2\theta\right)\right\}$$

in which V is the velocity of aether wave-motion—i. e., that of light.

This easily reduces to $\frac{2}{3}\frac{e^2}{a}v$, the value obtained before, when v is small compared with V; while if $v=V$, I becomes infinite.

Referring now to Kaufmann's experimental results mentioned above, attention is directed to the following table:

I.	II.	III.	IV.
v.	$\frac{e}{m}$	$\frac{m}{m}$ (Exp.)	$\frac{m}{m}$ (theory)
2.36×10^{10}	1.31×10^{7}	1.50	1.65
2.48 "	1.17 "	1.66	1.83
2.59 "	0.97 "	2.00	2.04
2.72 "	0.77 "	2.42	2.43
2.83 "	0.63 "	3.10	3.09

Column I gives five speed values actually measured of β-rays from radium. Column II gives the corresponding e/m for each experiment. Column III gives the five respective values calculated from the results of experiment, of the ratio of the mass of radium corpuscles to that of cathode ray corpuscles. For these latter particles $\frac{e}{m} = 1.95 \times 10^{7}$, the speed being less, the charges being of course the same. In column IV are found the ratios of the same masses calculated from the theoretical formula by substituting the different values of v given in column I. Attention is called to the very close agreement between columns III and IV, and also to the very weighty evidence thereby offered that the total mass of a moving corpuscle is electrical. It is surely worthy of note, too, that the agreement is closer for the higher speeds; which farther strengthens one's belief in the theory that all mass is electrical.

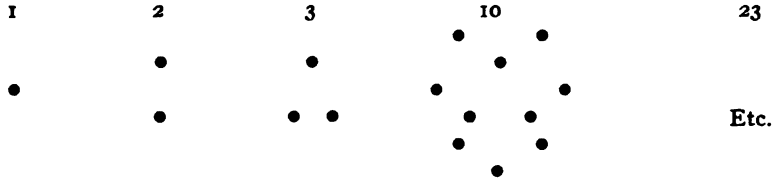
Consider now the effect of such impact of these particles or corpuscles as occurs in a Crookes tube. According to our theory each corpuscle is accompanied by lines of force having inertia. Because of this inertia the parts of lines at a distance from the corpuscles do not participate at once in the effect of the impact, since this effect has to travel along each line outward from each particle with the speed of aether wave-motion. The conclusion is that these radiating pulses constitute the Rœntgen rays, and the results of some recent researches of Blondlot for the purpose of measuring the speed of propagation of these rays are consistent with this view. Blondlot seems to have shown by experiment that the Rœntgen rays travel with the speed of light.

Since it has been proved by experiment almost beyond question that the corpuscular carriers of negative electricity are always of the same mass from whatever source derived, the idea is at

once suggested that these bodies may be the units from which all kinds of atoms are formed, this unit of building material being the same in all substances. The following crude illustration may help to make this idea conceivable: For example, a whole city (a molecule) or group of cities (a mass) might be composed of separate buildings (the atoms), either all alike (an element) or of many shapes and sizes (a compound), while every building might be made of bricks (the corpuscles) exactly alike in every respect. This notion that all matter in its simplest state is of only a single kind is, of course, not new, though the very forcible experimental evidence indicating such a state of affairs has been offered within a comparatively few months. While it may be urged that another step has indeed been taken but only deeper into the mystery, yet assuming the truth of the above conclusion, we find ourselves now face to face with a *single* problem instead of many, the solution of which would open wide the door to a comprehensive knowledge of many things now unknown and formerly unknowable. If we assume that a volume of the jelly-like aether—very large compared to a corpuscle—is surrounding a group of corpuscles, the latter filling this space with lines of force mutually repellant, but all gripping the aether, we shall have a structure behaving dynamically just like a uniform sphere of positive electricity, throughout which are scattered particles of negative electricity or corpuscles. The spherical positive body will exert a force on each negative electron directed towards the center of the space and in magnitude proportional to the distance from the center directly; while each pair of negative bodies will mutually repel with a force inversely proportional to the square of the distance between them.

Because of these two kinds of action, it occurs to one at once that combinations differing both in number and in configuration must also be unlike in their stability of permanent identity. Suppose we consider the conditions of equilibrium for different numbers of corpuscles. If the number be small enough the problem can be solved easily; e. g., in the case of three, the arrangement will be in the form of an equilateral triangle; of four, in a square or a regular tetrahedron. For larger numbers the forms that result can best be determined and studied by experiment. As a suggestion of how this might be possible, suppose a number of

magnets floating vertically in a liquid, similar poles up. Above this system with an opposite pole directed downward, station another magnet; the following plane figures will be formed by the floating poles, depending on the number:



As the number increases it appears that the arrangement develops into a series of concentric symmetrical forms, the innermost one developing from a single unit. For example, the triangular formation occurs first with three units; next with ten; then again with twenty-three, two rows encompassing the three-part center, and so on for larger numbers.

This is suggestive of the recurrence of definite chemical properties periodically when the elements are arranged in the sequence of their atomic mass values, since it would be most reasonable that the properties of a substance should depend, in part at least, on the configuration as well as on the number of its atomic units. This theory also indicates a possible relation and its cause, between the different spectrum lines of an element, as well as that between the spectra of allied elements.

Consider the vibrations in the case of a simple form, e. g., the triangular arrangement. As each corpuscle has three degrees of freedom of motion there could be as many as nine periods of vibration, though probably not so many would actually occur, as they would not likely all be different; so the spectrum might consist of a number of lines up to nine as a maximum. Again, in the next occurrence of the trio, there will be ten corpuscles in all, seven around the triangle. By influence of the seven the periods of the inner three would be somewhat changed, and those that were equal when the grouping consisted of the triangle alone must now be slightly different because of the dynamical asymmetry of the system, giving rise therefore to double or triple groups of lines. A higher complexity of the structure, which implies a greater atomic mass, would result in more complex spectrum groups—as,

for example, greater and different spaces between the components of different lines.

Any theory suggesting a satisfactory view of the sub-atomic structure of matter must account for the individual stability of the atom. If we consider the necessary expenditure of energy for atomic disintegration, it is evident that in some way it must depend on the number of corpuscles, and on the value of their corresponding charges, as well as on the mean radius of the whole system. That is:

$$\text{atomic energy} = \varphi\ (n)\ \frac{e^2}{a},$$

in which e is the charge on each of n corpuscles assembled into a group of average radius a. If r be taken as the radius of one neutral unit composed of a negative corpuscle embedded in its complementary positive electricity, then $nr^3 = a^3$, and the above energy formula becomes:

$$\text{atomic energy} = \varphi\ (n)\ \frac{e^2}{n^{\frac{1}{3}} r}.$$

Now the obvious condition that this atom shall not split up into two is that:

$$\frac{\varphi\ (n)}{n^{\frac{1}{3}}} < \frac{\varphi\ (n_1)}{n_1^{\frac{1}{3}}} + \frac{(n_2)}{n_2^{\frac{1}{3}}}$$

in which n_1 and n_2 would be the number of units in each part, $n_1 + n_2$ being equal to n. If $\varphi\ (n)$ is proportional to a power of n less than the three-fourths power, this unequality will not be satisfied for any value of n, and an atom coming into that dynamic state from any cause would be unstable and break up, the neutral units redistributing themselves according to the new conditions, so that the dependence of energy on the number of units would be according to a power of n large enough to have the above condition satisfied. Again, it is possible that for higher values of n the test of stability would indicate the existence of an atom to be impossible; where for values of n near the limit the atoms would be on the verge of being unstable. Just in this connection attention is called to the fact that radio-active substances, such as radium, thorium, uranum, have the greatest atomic masses known, i. e., they are on the border line of stability. In fact, as already stated, it is certain that radium emits positive emanations, the mass of which Rutherford finds by measuring $\frac{e}{m}$ to be of the

same order of magnitude as the atomic mass—strong evidence surely that the atom has divided. As it is probable that atomic stability depends on external influences, it is possible that some of the elements familiar to us now could not have existed at an earlier period of the earth's history because of such wide differences in such conditions as temperature, pressure, etc. Again, possibly others might easily have been stable under former conditions, but are not so now and have been going out of existence for a million years or so—the present age, with its ultra refined methods for investigation being just in time and prepared to catch a few milligrams of the last traces of such as radium and polonium. Startling, indeed, would it be if the newspaper reports of the last few days that Ramsay has actually turned radium into helium should prove true!

Some other recognized atomic properties may be simply explained on the electric theory of matter. Consider an atom which just before coming into its present state lost a negative electron because its internal kinetic energy was a little too great to be consistent with its gradually changed surroundings, and the most active corpuscle escaped. This leaves the atom positively charged and stable because the next most active corpuscle will not be able to get away because of the now increased positive attraction. In this state the atom would be a monovalent positive atom. Others might naturally be so internally active as to require the escape of two or three corpuscles to render them stable, resulting in a bivalent or trivalent atom. Again, others might be so stable as to be able to acquire one to three corpuscles without becoming unstable; these would be electro-negative atoms. Suppose we consider an atom of hydrogen. It is just unstable enough to have to emit one corpuscle, say (of its thousand) to become stable, and thereby positively charged. A nearby chlorine atom is so stable as to be able to take one corpuscle without becoming unstable, and so it will become negatively charged on receiving the corpuscle expelled from the hydrogen atom, and the H and the Cl will unite to form a molecule of HCl. If oxygen, instead of chlorine, be present, it is so stable as to be able easily to absorb two corpuscles, and we find it attracting the superabundance of two atoms of hydrogen and a molecule of water is formed.

Valency would then obviously depend on external conditions, a conclusion long since arrived at by chemists from other considerations.

To account for the combination of atoms of the same substance to form a molecule, suppose, as is quite reasonable, that for a given number of corpuscular units of positive and negative electricity, the stability is a function of the atomic speed, the intensity of impact, or depends on the surrounding medium perhaps. The average kinetic energy of the whole may stay constant while that of single units differs at any instant widely from that of certain other ones. At any particular instant, then, some units will be unstable and others ultra-stable, and pairing off will result as before. Dissociation of molecules accompanying high temperature is explained on the electric theory by assuming the negatively charged atom to lose some corpuscles, leaving it positive and so repelled by its mate already positive.

The chemist will at once picture our unit force tubes as his diagramatic bonds and the analogy is good, though the identity is not quite complete. Take, for example, C_2H_6, arranged:

```
H—\+                  +/—H
H——+C+———————C+——H
H—/+                  +\—H
```

It will be seen that the two carbon atoms are structurally different, one having less and the other more corpuscles than average. A greater difference in the carbon atoms must result from this theory in such a compound as C_2H_2, arranged:

```
                  + ——
H —— + C ÷ ——C+—— — H
                  + ——
```

From the evidence set forth in the foregoing pages, both direct and indirect, the thoughtful reader can but feel that, possibly, even probably, *electricity* and the *aether*, not so long ago omitted from both of the great classes of objectivities, may yet be shown to be one and the same thing, and that this is the *only* objectivity in the physical world.

PATHOLOGIC CHANGES IN TISSUE UNDER THE INFLUENCE OF THE X-RAY.

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Of Philadelphia, Pa.

The subject of the pathologic change in tissue under the influence of the X-ray is one of considerable latitude, and in this article, it will be covered only in a general way, as detail must be avoided on account of time. In dealing with this subject in another paper, it was considered under two heads, first, the change observed in normal tissue, second, in abnormal tissue; and the conclusions reached at that time seem to still hold good, i. e. That no single form of degeneration observed is alone characteristic and that it depends entirely upon the tissue exposed and the method of X-ray application. Here may be seen the scope of this study and the cause of the great difference of opinion that exists among various authors. In some ways the effects of the X-ray might be compared to fever, as for instance in a case of high fever, the first degeneration that usually takes place is a hylo-granular, then if the temperature continues a fatty change follows, the recovery here, depends upon the amount of damage done before the fever subsides. In another case where the fever is continued for a long time with remission and intermission, we have the more chronic forms of degenerations such as the amyloid change, etc. The X-ray is capable of the same latitude. Those who have watched an X-ray tube in operation and noticed how the vacuum will change from time to time will wonder how any constant result can be obtained, but the operator after a little practice will be able to judge to a great extent about how much energy a certain tube is capable of giving under certain circumstances.

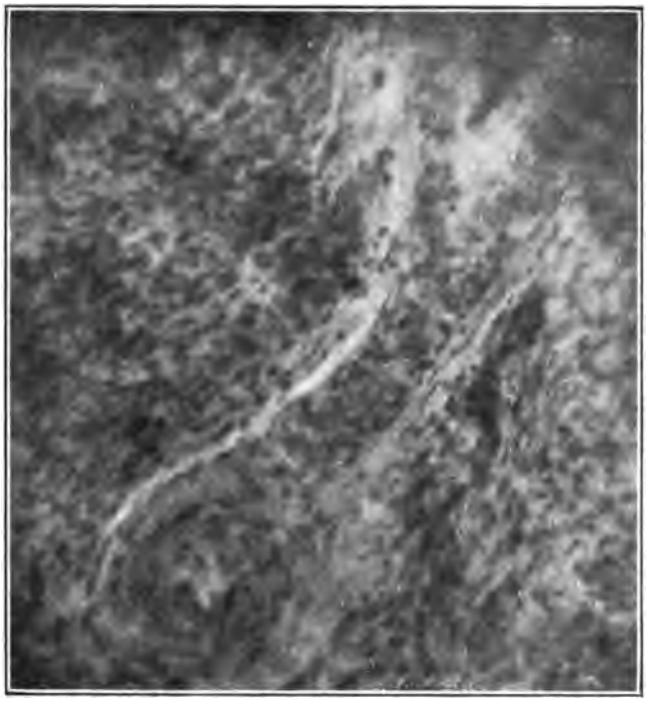
Then again with this wide variance of X-ray energy, we have a still more important irregularity to consider, and that is the tolerance of the X-ray by certain individuals, always

being on guard for that person who has a susceptibility to unpleasant effects. And what seems still more extraordinary is the fact that a person will tolerate a certain amount of X-ray from one apparatus, while apparently the same amount from another will cause trouble. No doubt this is due to our imperfect methods of measuring the amount of X-ray energy. Some have thought that the so-called "brush effects" have a great deal to do with these unexpected results, but if this is so it seems queer that we have not seen these changes before in other fields, but this subject still needs some careful study.

The effect of the X-ray upon tissue must differ from any thing else, for the reason that it penetrates to such a depth, and upon the surface, while its energy is only modified by the distance from the source, and the resistance of the intervening tissue. The question of how the X-ray acts, must be overlooked for the time being, unless we accept the explanation that it is an electro-chemic disturbance of the ultimate cell elements.

The inflammatory effects of the ray upon the tissues of the body have been termed a "burn," although some objection has been raised to this term, it seems to fill the sense in this instance, just as when used for an ulceration caused by some chemical. This effect may be so slight as to cause only a perceptible reddening of the skin followed by a faint tanning, with very little local disturbance, and no systemic effects. From the work of some German authors in this field it would appear that this process closely resembles sunburn, but the effects are much deeper. In the case of severe burns the process is unique in itself and differs from all other forms of degeneration and regeneration, although very irregular in its course. The period of incubation may be from a few hours to months, and during this time the patient may complain of severe pain in the affected part, in some instances the pain may be quite severe but intense pain does not necessarily mean a severe burn, in fact what might be termed a mild burn often produces the most discomfort. The general systemic disturbances in these cases are quite as irregular but in a general way follow the course that might be expected from ordinary ulcerations in the affected part. The first observation is that of a surface

Section. Spindle Cell Sarcoma, showing cell degenerators and vascular changes.



(Higher Magnification) of No. 1, showing section of blood vessel.

hyperæmia, which is followed in a few days or even longer by a slough which gradually extends over the whole involved area. Its appearance is deceptive, it looks as if it could easily be removed, but on the contrary it is quite adherent, however, after a given interval, part by part will separate and, as these pieces are removed, the underlying structures have the appearance of healthy granulation tissue, but in a few days another slough will form. This process will sometimes continue for months. The appearance of the slough is like that of a bad scald, it is usually moist but differs from it in the fact that it is extremely hard to remove and will often cause intense pain. The explanation may be this: In the case of a scald the tissue dies *en masse* and separates *en masse,* while in the case of the X-ray burn the cell necrosis is only one cell at a time, the living cell and the dead cell are intertwined, no doubt that many of these cells would recover if their nutrition was not impaired by these surrounding dead cells, and acting like any foreign body would also cause pain.

When the slough of an X-ray burn is carefully removed it gives the appearance of a highly magnified tabeculæ, or a homelier simile, that of a honey comb. The line of demarcation usually seen in other forms of gangrene is practically never seen here, and even when the ulceration has greatly diminished in size by healing, these sloughs still continue to form. The scars of these burns are curious. In very severe cases where the deeper structures are involved they resemble those from fire, but the surprising fact is, that when the ulceration does not go below the superficial structures practically no scar will be formed and in a month or two after the ulceration has healed, the skin will be as soft and pliable as that which surrounds it.

At this point it would be well to call attention to a membranous deposit that forms upon moist ulcerated surfaces, when the X-ray is applied over a long interval of short exposures, producing only a slight amount of reaction; from its appearance it would suggest diphtheria, except it is whiter and not so dense, although when it is removed it leaves a bleeding surface. It closely resembles the slough of a bad burn, except that the membrane is entirely superficial.

As is well known these X-ray burns are extremely painful in most cases, yet at the same time in some instances the X-ray will relieve pain; even anesthesia of the exposed part has been observed. Several theories have been advanced in explanation of these facts, but so far we have no substantial proof. In the case where anesthesia is produced after X-ray exposures where no pathologic process exists, the explanation might be, that there is a temporary degeneration of the terminal nerve filiments which causes an impairment of function. This can hardly be offered as an explanation in the case where the pain is relieved in cancer, yet it will be noticed that if these cases receive too much X-ray treatment, they will suffer pain but of a different character from the pain before treatment. These facts, however, would suggest that the effects of the X-ray must be upon the cell elements in the exposed parts. In other words, when a cancer is being treated and the X-ray is applied in sufficient quantity to relieve pain, there will be very little disturbance of the part, on the other hand when too much X-ray treatment had been given an active inflammation follows, which involves outside structures and pain is the consequence.

The study of the effects of the X-ray upon tissue microscopically, in all instances offered here has been upon pre-existing disease. It has not been my fortune to be able to procure a case of simple burn, and in most instances these cases object to the knife; therefore, this study is doubly tedious. Some facts have been brought forward that seem to hold good in normal and abnormal cases, but on the other hand there still exists a great deal of mystery that seems almost impossible to explain; take for instance, a malignant growth surrounded by healthy tissue, it is exposed to the X-ray and it simply melts away, there is very little disturbance of the surrounding tissue, not only macroscopically but microscopically as well. This is well illustrated by the following cases.

Mrs. X. for several years has been suffering from an epithelioma of the face just above the alæ of the nose; it was at the time of treatment about the size of a five-cent piece. A section was taken from the edge of the ulceration just before the first treatment, and the microscope confirmed the

clinical diagnosis. X-ray treatments were given three times a week, from an 18 inch coil, on a 110 volt current, at 3 amperes, the vacuum of the tube was about 5 inches, spark gap, the tube being 10 inches from the patient and time of exposure 10 minutes; the flouroscope showed only a dull shadow of the hand. After the sixteenth treatment, another section was removed from the edge of the ulceration which at this time had healed to about one-third its former size; during the process of healing literally no reaction of the surrounding skin was produced and upon examination of the section very little difference could be seen except for some slight degeneration of the cells, otherwise it was a typical epithelioma, and a few weeks later, after the ulceration had healed, sections showed simply typical scar tissue.

About the same observation was made in the case of Mr. S. which will be mentioned later.

Although in the reports of cases there is a wide difference of opinion as to the kind and degree of degeneration, many authors speak of the vascular changes and most of them seem to agree that there is a thickening of the vessels, as was observed in the following case.

Mr. P., carpenter, 34 years of age, spindle cell sarcoma of the leg. About five years ago he noticed a small tumor over the tibia about four inches above the malleolus; at first it did not annoy him, but as it grew it became painful. He refused any radical operation but about three months before he began X-ray treatment, the mass was removed; at that time it was about the size of a split base ball. The wound did not close satisfactorily and recurrence was very rapid. At the time he began X-ray treatment, several nodules about the size of marbles existed along the line of a very indurated and excavated scar, which was about two and a half inches long. They offered what would seem to be an ideal case for tissue study, and it was the intention at that time to remove these nodules at intervals of every two weeks, but under daily treatment they disappeared in less than three weeks, and only one nodule was removed on the ninth day. The X-ray was from a 15 inch coil, 6 storage cells, a Queen tube at about a 4 inch vacuum, the tube was about 10 inches from the patient and each treat-

ment was 10 minutes. It might be said here that the ultimate result was not as favorable as it might seem to be, for it recurred about six months later and the man discontinued treatment. The reason for removing the section before the fourteenth day was due to the great softening and diminution to almost half the original size. There was at this time considerable erythema of the over-lying skin. The sections showed considerable cell degeneration with invasion of leucocytes and a thickening of the vessels with deposits on the inner surfaces, the amount of degeneration did not seem to be in accordance with what might be expected. The vascular disturbance here was rather interesting, in a part that was rapidly diminishing the vessels were thickened and in places were almost closed by cellular deposits, yet in the other cells there was a retrograde metamorphosis.

The plugging of the vessels might explain the formation of these gangrenous patches after X-ray exposures, yet if this was the only cause, the degenerative process might be expected to subside sooner than it does, at the same time we might expect other embolic complications. Perhaps these cases of pneumonia that have followed X-ray burns are due to this cause.

In another case of epithelioma of the face (Mr. S.) of thirty years' duration, sections were examined from the edges of the wound; the first section was taken after the first treatment and the other about three months later. There was very little difference between the two sections although the ulceration had closed in considerably, but while this was occurring another curious process had developed over certain areas particularly in the deeper portions. There appeared a quite prolific growth of granulation tissue, of a pinkish color, much the same appearance that this tissue presents around tuberculous sinuses which have just been well washed with peroxide of hydrogen. Microscopic examination simply confirmed the clinical observation.

The examination of three sections from a rapidly degenerating epithelioma of the chin showed very little difference between the different sections. They were taken from the

edge of the ulceration; the disease occurring in a man forty-six years of age. The X-ray in this case failed to produce any improvement, in fact it seemed to produce more irritation.

At this point it would be well to consider some of the work that has been done in this field and it will be noticed that a wide variance exists in the summaries.

Sequeira states that two definite effects from the X-rays are observed upon microscopical examination; first, a destruction of the epithelial cell, the neucleus and protoplasm undergoing lysis; in some cells there was a definite fatty change; second, a stimulation of the connective tissue elements causing the formation of healthy scar tissue.

Walker in sections from a rodent ulcer, healing under the influence of X-ray found that a fibro-myxematous degeneration was taking place.

Beck found a colloid change in an adeno-carcinoma.

McCaw found the same change in an epithelioma of the uvula.

Ellis summarizes from the microscopic examination of four cases; First, necrosis of cells and trabeculae of varying degree, in case there was also marked fatty degeneration, fewer areas of lympho-cytic infiltration in one case after exposure, about equal numbers in the others, a tendency to occlusion of the vessels by deposits on their inner surfaces, practically entire absence of infiltration by polymorpho-neuclear leucocytes.

In regard to this last point, Dr. Ellis's observations are rather interesting, from the fact that he has given this point very careful study. Mayou in contradistinction to the above and like most other observers, found a large number of leucocytes, but differs from most others in the fact that he observed that the vessels were dilated. In another instance of a large tumor that had greatly diminished under the use of the X-ray, no change was noticed that could be attributed to its use.

Stewart assisted by Nickerson, Wilson and Man made an exhaustive study of a case of epithelioma of the hand and came to the following conclusions: 1. It is possible that when

epitheliomata react favorably to X-ray treatment, characteristic histologic changes will be found. 2. The important early changes are fatty degeneration and vascularization of the epithelial pearls. 3. Leucocytic infiltration and various degeneration processes complete the destruction. 4. Bodies indistinguishable from "Plimmer's bodies" multiply as the epithelia degenerates.

When comparing the above results we find them directly opposite to those of Dr. Ellis; and the reason no doubt is due to the different clinical methods used in the X-ray treatment. In the case of Dr. Stewart, no doubt there was some X-ray reaction, that is an over-action, while in the case of Dr. Ellis, there was no great amount of reaction. This fact will be noticed in the difference between the case of Mr. P., Mrs. X., and Mrs. S., and leucocytes might be looked upon to hold the following position. First, that they will be observed where we have an over-stimulation of the parts by the X-ray. Second, in the cases that show no reaction, leucocytes will not be observed. Allen, however, concludes that leucocytes are increased in the exposed areas immediately.

Some other points in Stewart's paper need careful attention. He refutes the statement of Unna that epitheliomata never undergo a fatty change, and as to the vascular changes, he observes marked evidence of the formation of new blood vessels, noticeably in the centers of the epithelial pearls. His specimens showed no signs of an obliterating endarteritis.

Pernet examined tissue from a case of lupus vulgaris, which six months previous had received about fourteen treatments of about ten minutes each daily. He found the collagium was disjuncted and to some extent disintegrated, the elastin had been destroyed. The hair follicles and sebaceous glands had also disappeared, while the sweat glands showed surrounding infiltration and degeneration. A large vessel in the subcutaneous stratum showed thickened walls, and in places the upper layer of the corium showed a fibrous change.

From the above observations one would naturally expect considerable disturbance of the normal tissues, when they cover some deep growth that is being treated, especially so in the

case of abdominal tumors, yet in many instances large inoperable masses have been treated, until complete absorption has taken place, and with very little disturbance of the overlying skin. No doubt some change does take place but it never seems to lead to any grave consequences.

The opinion has been expressed by some, that all cases of malignant disease should be treated until considerable reaction is observed, but this intense reaction is not necessary, for in fact when these cases react favorably to the X-ray they will usually do so with very little disturbance of the surrounding structures, and an over-reaction will only lead to a necrosis of the tissues and the healing process will be delayed, while the patient will suffer more pain. In some instances it has been looked upon as the cause of recurrence of the disease. Some X-ray operators advise the use of the ray until a severe burn has been produced with the idea that it will have a good effect in retarding metastisis. This has not proved to be so clinically, and when one considers the natural history of these cases, this idea is absolutely lacking in support, considering the limited area treated, and then how early and how distant these metastatic processes have been found in the normal case. Sections from the case of K. G., were made from a nodule under the right axilla, the original scirrhus was of the left breast.

Another false idea exists regarding the prognosis of deep and superficial growths, the last are supposed to be much more amenable to treatment, the fact is, however, it is not the location of the disease but the form. The natural course of a superficial skin carcinoma is often thirty years, commonly fifteen years; now compare this with the rapid progress of a breast or gastric carcinoma and an entirely different aspect presents itself; in the cases the primary process may be treated with success when a secondary process is discovered, and in rapid succession others follow until the patient succumbs of exhaustion. Slow growing deep growths have done well under X-ray treatment, while on the other hand rapid growing superficial growths will often be irritated.

It would be impossible to review in detail all of the different phases of this subject and discuss them; but from what

has been given the conclusions might be as follows: First, that no single form of degeneration is alone characteristic of the X-ray, and that the form of degeneration observed depends entirely upon the tissue exposed and the method of X-ray application. Second, it would seem that the effect of the X-ray is upon the cell elements in the exposed parts, but why certain normal cells, such as those in hair follicles, new growths, etc., should be more suspectible than other tissue is still a question of doubt, but in view of the vascular disturbance found by many observers it might be thought that this cause plays an active part.

Sequeira, Brit. Med. Jour., Oct. 25, 1902.
Beck, New York Med. Jour., May 24, 1902.
McCan, New York Med. Jour., Aug. 2, 1902.
Ellis Amer. Jour. of Med. Se., Jan., 1903.
Mayon Medicine, p. 205, 1903.
Marsh Medicine, p. 205, 1903.
Stewart, Nickerson, Wilson and Man, Jour. A. M. A., July 18, 1903.
Pernet Lancet, Sept. 6, 1902.
Allen, Jour. of Med. Research, June, 1903.
Beck, Wm. Wood Co.
Coley Med. Record, March 21, 1903.

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DISCUSSION ON PAPER OF DR. NEWCOMET.

DR. GORDON G. BURDICK, Chicago: *Mr. President*—I must take exception to the last statement made by Dr. Newcomet. He says, if I understood him correctly, that certain slow growing growths always do well, and that the rapidly growing growths do not; that they are irritated by the X-ray and are thus stimulated to excessive growth. I cannot understand that. I have not observed that in my practice; in fact, I have not as yet been able to see a single case in which I found stimulation of growth. On the contrary, I have always been able to check them without difficulty.

He says that the tubes he uses have a five-inch projection in a parallel spark gap. That is a very penetrating ray; and not more than two-thirds of the energy is carried to where you expect the work to be done. Those rays without question have a stimulating effect. We know that there is a difference between the East and the West in the technique of using the rays. We, in the West, as a general proposition, do not send the rays any farther than we expect work to be done. We obtain just enough penetration to send all the energy we can force into a certain depth and no farther. Consequently we do not get any stimulating effect when we desire to break down a tissue. We never get the results reported by Dr. Newcomet who uses these high penetrating tubes. We get better results by using a tube having a lower degree of penetration. Our osteosarcomata and spindle celled sarcomata shrink very rapidly under exposure to a low tube. In my own experience I find that the low tube always checks the growth of the tumor very promptly.

As to the pathological changes we observe in these tissues after exposure to the ray: It seems that the epithelial or cellular tissue suffers at the expense of the connective tis-

sue; but our pathologists are not yet satisfied whether the epithelial tissue is choked by the connective tissue overgrowth, or whether the cells are killed and the connective tissue merely takes their place. Several times I have had the privilege of seeing rayed bone where under the exposed necrotic surface all the blood channels were destroyed by the ray and the bone had become petrous like the petrous portion of the temporal bone, and we all know how dense that is.

DR. JOS. C. CLARK, Olean, N. Y.: I have very few facilities for doing microscopic work, but it has been forced upon me as a very palpable fact that the longer the history of the case the surer the results; the more acute the case the more certain are you to produce irritation. This is a clinical fact that I have observed time and again, and it is in accord with the statements made by Dr. Newcomet. What Dr. Burdick said about the differences in the methods in vogue in the East and the West may be true, but we, in the smaller cities, have so few facilities that we labor under a disadvantage. We are unable to control the penetration of the ray so we get along the best we can, but after having had a few experiences we leave the short history cases alone. They are irritable cases and the outcome is never a favorable one. We let them go to the men who use caustics.

DR. WESTON A. PRICE, Cleveland: A very vital point has been raised by Dr. Burdick referring to the penetration of a tube, and it may be well to settle it here and now while the thought is with us. It is my belief that all tubes produce a variety of penetration from high to low. Even a so-called low tube, gives off some few rays of very high penetration. And all high tubes give off rays of low penetration. I would like to have Dr. Burdick tell us how he can select a tube that will have rays of a known and only one variety of penetration.

DR. HENRY HULST, Grand Rapids, Mich: It was not my intention to say anything at all on this subject, but the discussion has brought up one or two points which induces me to rise and speak.

Dr. Burdick in speaking of the relative use of the high and the low tube made the assertion that a tube permitting a current to go through equal to a parallel spark gap of about five inches was a high tube. I think that it is the experience of most of us that that is not necessarily the case. I have a tube in my laboratory that will resist almost any spark, yet the ray given off by that tube is very low in penetrating power. To measure the penetrating power of tubes by parallel spark gap is worse than useless.

Another statement made was that the ray produced by a very high tube is stimulating to the growth. I think that the doctor stated that this was the universally accepted opinion. I doubt this somewhat. I think that it has been quite well understood that the first effect of the X-ray upon tissues everywhere is that of stimulation, and that the next effect is depressing, or even fatal to the organism or tissue, and therefore, similar to the action of many drugs. I suppose that the difference in the physiological effects of the X-ray depends largely on the quantity that is absorbed. A very penetrating tube gives off rays that go right through the body, and they do no work in the body but elsewhere outside of the body. Therefore, its effect would be similar to that produced by a small dose of a soft tube. Since the primary effect is stimulating and the secondary effect depressing, the rays given off by a higher tube are not absorbed so much, and therefore do not produce such secondary depression as we get when using the low tube.

Do not treat a skin lesion with a ray that will go through a brick wall. It is not good economy nor is it good sense.

Dr. Burdick: It is a very hard proposition to explain the theory that lies at the basis of my work, but I believe that possibly I can give you an idea as to how I do my work, and how I can estimate the penetration of my tubes. In the first place, all my therapeutic tubes are reduced below the line where my X-ray at all is given off. Of course, I take it for granted that I have a perfectly constructed tube to begin with so that it can be reduced. With the vacuum below the line where any ray is given off we can control the degree of pene-

tration of the X-ray by the speed with which we drive the cathode stream, and that is controlled entirely by the electro-motive force of the apparatus. This you can raise as you desire by putting resistance in your circuit. If you have a skin cancer to treat, or if you desire to remove superfluous hair, or something like that, all you need is about one-eighth inch spark gap on both sides of the coil and you will find that you have just sufficient degree of penetration, as you can prove by the photographic plate, and there is absolutely no reason why you should send the rays right through the body in these cases.

For epitheliomata never use more than one-fourth inch spark gap on each side. I find that it takes only a very few treatments to get all the irritation desired to bring about a cure, and I do not hesitate to tell my patients positively before I begin to treat them for these superficial lesions that they will be cured in a certain definite time.

If you desire to treat deeper seated lesions, all you have to do is to increase the electro-motive force; put more resistance in your circuit and the force will drive the cathode stream more rapidly and you get a more penetrating ray. It is as simple as anything can be. All you need is a tube that you can keep down below the line. I reduce mine two or three times a day and have no difficulty whatever in doing it.

The fluorescent rays that come from a high tube are stimulating, but are not necessarily the chemical rays which, I believe, is the reason why we obtain a great deal more therapeutic effect from a low tube. I believe that the fluorescent ray itself has very little photographic power. That cannot be illustrated in any better way than to rotate the static machine at a certain definite rate of speed. We get a good fluoroscopic image, taking the fluoroscope as the degree of penetration. But if we take the same tube, put it on a twenty-four plate machine and run it at the same rate of speed, we get no better fluoroscopic image. It is the same because the electro-motive force is the same. But there is a difference and it is shown only by the photographic plate. If you place a photographic plate there you will find that you absorb just twelve times as

much energy from the twenty-four plate machine as you do from the two plate machine because we have forced more current through the tube. Therefore, we put in motion more of the corpuscles in the tube and we derive a richer chemical light.

DR. NEWCOMET (closing the discussion): The discussion has drifted away from my paper. The assertion I made is I believe that deep growths of slow growing character will do as well as slow growing superficial growths. Rapidly growing deep or superficial growths will not do so well under treatment by the X-ray; as they soon produce metastases in other parts of the body. This is not because of the local effect of the rays but because of the rapidity of the growths. Slow growing growths always do well under all conditions.

THE RESULTS OF THE ROENTGEN METHOD IN THE DIAGNOSIS OF RENAL CALCULUS.

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In order to be recognized as a valuable method of physical diagnosis, it was essential that the Rœntgen method should produce, not only better results, but also results that could not be secured by any previously known method of diagnosis.

This has been accomplished. Greater accuracy and detail have been obtained earlier and with less inconvenience, pain and injury to the patient. This has been demonstrated in the diagnosis of fractures, dilocations and osseous deformities. It has gone far beyond other methods in localizing foreign bodies that have entered the tissues, and calculi that have formed within.

The diagnostic value of the Rœntgen method should not be lost sight of in the enthusiasm of Rœntgen therapeutics. The full value of this method has not been reached in diagnosis; there are many lines in which the development of efficient technique will result in valuable progress. There is much that can be done by the students of this method to aid in the advancement of medical science. It is their duty to teach the general practitioner the value of this method. The progress of medicine will be furthered the more he is made to realize this. The aid of this method has been sought and its value acknowledged by the leading minds in medicine and surgery. They have shown their scientific worth and training, by welcoming and employing this agent because it will increase the accuracy of their diagnosis, and aid them in treating their patients. This method has only been decried and its possible errors magnified by those who seem to fear, that, if they admit it can aid and is of value, they will lessen the worth of their expert opinion. It will not be employed as a routine measure until its use is demanded by the general practitioner in the interests of his patient. When the value of this method has

been demonstrated to the medical public they will seek those surgeons who appreciate and employ it. They judge of the calibre and scientific acumen of the surgeon, by his ability and willingness to employ the most accurate methods.

The application of the Rœntgen method of diagnosis to the detection of various concretions or calculi, that form in the hollow viscera, has been attended with marked success. These calculi are principally formed of inorganic salts, that ordinarily pass in solution through the organs in which they are found. Some slight derangement of function is apparently responsible for their formation, as a consequence they do not give rise to characteristic symptoms until they interfere mechanically with the function of the organ in which they are situated, or infection follows their depressant action. This is entirely in accord with nature's tolerance of all sterile foreign bodies. Such quiescent calculi are, however, a menace to the functional life and vitality of their host. The presence or absence of such concretions, should be determined as soon as they are suspected. The indefiniteness of the symptoms does not always permit this to be done, but the present Rœntgen technique makes it possible in renal and ureteral lithiasis, and an improved technique will make it equally possible in other calculous conditions.

The absolute negative and positive diagnosis of calculous nephritis and ureteritis, can be made with an error of less than three per cent. This is greater accuracy than has been obtained by any other method, in this, one of the most obscure fields of surgical diagnosis.

The result has been felt in altered indications for operation, and modifications in operative procedures, that have rendered them more accurate and comprehensive, while lessening the danger and necessary operative trauma. These advantages, and others that follow the employment of this method in calculus diagnosis, will be realized more fully, after a resumè of the results obtained in three hundred and five cases that have been referred for examination and diagnosis.

Calculi have been found by the skiagram in eighty-nine cases. Over sixty per cent. of these calculi were found in the

ureters. The total amount of error in the combined negative and positive diagnosis has been nine cases, or less than three per cent. of the cases examined. The negative diagnosis has been found as accurate as the positive, for only one calculus has been found in forty-six such cases operated upon. Three other patients passed small calculi that had been overlooked. In the cases where a calculus was thought to be present, and none were found, the patients were some of them exceedingly stout, and an absolute diagnosis had not been rendered; in others, the operation for a small stone was delayed a sufficient length of time for the calculus to have changed its position. In one case a large calculus was not found by one operator, but was subsequently removed by another, and the accuracy of the Rœntgen diagnosis confirmed. This case and others in which calculi have been missed by expert operators, and subsequently found by the Rœntgen rays, and later removed, show how readily the surgeon may overlook a small calculus. The greatest care must however be taken in reading the negatives in this diagnosis. The negative must first be recognized as having sufficient detail to show all calculi, as clear definition in bone shadows is not sufficient; contrasts must show in soft-tissue shadows.

The negative diagnosis is based upon the axiom "that where shadows of tissue less dense than the least dense calculus are shown, no calculus can escape detection." In order, however, to be accurate, the negatives must be carefully studied, and experience in reading them increases the accuracy of the diagnosis.

The greater accuracy of this method, over other methods of diagnosis, and even over operation, has been repeatedly demonstrated. In two cases calculi were found in a kidney, that had previously been operated upon and a small calculus removed. In three other cases calculi were found in the ureter, blocking it and producing a urinary fistula from a kidney that had previously been operated upon. Again in three cases calculi were found in the second kidney, after the other had been operated upon and calculi removed.

Such cases as these illustrate the greater accuracy, precision and completeness, of the Rœntgen diagnosis. They

show that it renders the operative intervention thorough and complete, while reducing to the minimum the amount of operative trauma. They guard the patient from the danger of operation upon the wrong kidney; of operation upon the kidney when it is the ureter alone that is involved; and of any calculi remaining behind to necessitate a second operation. The accuracy of this method localizes to the exact seat of the calculus, the operative intervention, decreasing the trauma and necessary shock.

One of the gravest complications of nephrolithiasis is anuria. Unilateral anuria threatens the functional activity of the kidney involved. Bi-lateral or complete anuria threatens the life of the patient. Both demand immediate operation to remedy a most serious condition. The question in complete anuria was, formerly, which kidney to operate upon, and how to find and relieve the obstruction? This query can now be answered accurately by the Rœntgen diagnosis. But a condition almost as serious, and more difficult to diagnose is present in unilateral calculous anuria. The great danger and difficulty lies in the insidiousness of the symptoms. It is a condition that threatens the functional life of the kidney involved, because it totally obstructs the urinary flow, this finally leads to degeneration of the secreting substance of the kidney. The symptoms are not open and frank, they simulate recovery, while they actually mean destruction. When the ureter is completely blocked, the intra-pelvic urinary pressure soon equalizes the intra-nephritic blood pressure, the kidney ceases to act, there is no longer distension of the pelvis of the kidney, and of the ureter above the calculus and hence no more pain. The patient has apparently recovered from the attack. Unless a calculus has been passed and detected, or the presence of a bi-lateral urinary flow has been proved, the patient, after the cessation of symptoms following an attack of renal or ureteral colic, is in grave danger. This cessation of symptoms may mean total obstruction of the ureter. The Rœntgen diagnosis renders it possible to relieve such a situation of all its danger, and render rational and safe, an expectant line of treatment, that will often result in the passage of

a calculus by natural channels, avoiding the necessity and dangers of an operation.

Every patient who has suffered from an attack of renal or ureteral colic, unless a stone has been passed, should be examined by the Rœntgen method. If the symptoms have entirely subsided and a calculus is present, the existence of a bilateral urinary flow ought to be ascertained.

The value of this diagnosis, and of the expectant line of treatment that can be based upon it, is illustrated by a series of twenty cases, in which this line of treatment had been suggested, after the detection of small calculi in the ureter. It is not wise, in any application of this method of diagnosis, to depend entirely upon it in shaping the course of treatment. All the knowledge that can be gained by every possible method of diagnosis should be employed in each case. In no class of cases is this more true, than in calculous nephritis and ureteritis. The study of the symptomatology, combined with the findings of the skiagraph, have led to this more rational and safe method of conservative treatment, and these twenty patients may be said to owe their recovery without operation, to the Rœntgen method of diagnosis.

In only three cases in which this conservative treatment has been suggested, have the symptoms become so severe as to demand immediate operation. In all, the accurate localization of the calculi facilitated the operation, rendering it successful, and aided materially in producing in each case a favorable termination. Purely medical, or expectant treatment is unwise and irrational without the aid of this method, which safeguards the integrity of the kidney and makes accurate, effective operation, possible when the symptoms demand it.

Besides forming the basis for new indications for operation, and rendering the operation more complete, it has freed it from some of its graver dangers. Multiple and bi-laterally situated caculi are detected, and the operation freed from the danger of overlooking them, or of operating upon one kidney or removing it, when the other is the seat of calculous disease. That these dangers are real ones, is shown by the detection of multiple calculi in twelve cases.

Stone in Ureter; confirmed by operation.

The accuracy which has been secured in the negative diagnosis leads to the opinion, that where an operator has attained the essential accuracy, and his skiagraphs show no calculi in the kidney, an incision into the kidney in the search for calculi is not justifiable, unless some microscopic pathologic lesion is present as an indication.

In favorable cases greater detail can now often be obtained, that suggest greater possibilities in renal diagnosis. Thus pyro- and hydro-nephroses, displaced kidneys, tubercular kidneys, and surgical kidneys have been demonstrable or suggested in some negatives, and have afterwards been found at the operation.

The Rœntgen method has been of great advantage in differentiating calculous nephritis and ureteritis from other conditions in surrounding organs or in the kidney itself, that simulate the symptomatology of renal lithiasis so closely as to render a differential diagnosis very difficult.

Thus a calculus lodged in the right ureter, where it crosses the iliac artery, a very common seat for impaction, may suggest appendicitis or ovarian disease. The appendix has been removed, where the true condition was an impacted ureteral stone, by some of our best surgeons, who afterwards removed the calculus. The ovary, has undoubtedly been removed or operated upon in a similar way. This possibility is easily conceivable when we consider that the Rœntgen method of diagnosis has shown that more than half the calculi that form in the kidney, do not give rise to symptoms of moment until the reach the intra-pelvic portion of the ureter.

The results of the Rœntgen method of diagnosis in conditions of renal lithiasis have, therefore, been the more ready differentiation of calculous conditions from other pathologic processes in the kidney and surrounding organs, by a method that is more accurate, precise and comprehensive, while it is without danger, inconvenience or pain to the patient. It has facilitated operation by giving the exact size, location and number of all calculi, thus confining the operation to the position of the calculus, and decreasing the operative trauma and shock. It has freed operation from the danger of doing un-

wittingly a nephrectomy upon the kidney, or other serious surgical intervention, while the second kidney is the seat of calculous disease. The wrong kidney cannot be operated upon for calculus, or calculi left behind when multiple calculi are present.

It affords a solution for the grave problems of complete and unilateral calculous anuria, and has rendered rational and safe a conservative expectant line of treatment, that without it would be dangerous. It has already saved many patients from the dangers of operation, guaranteeing their safety until they have been restored to health.

The negative diagnosis has been proved to be as accurate as the positive. It renders unnecessary any incision into the kidney during exploratory or other operations, unless there is some further visible pathologic lesion to justify it.

These demonstrated results make the use of this method imperative in all cases where calculus is suspected. After an attack of apparent renal colic, no course of treatment can be correctly or conscientiously undertaken, without the determination of the presence or absence of stone. It must be employed before every nephrolithotomy or ureterolithotomy to determine whether operation is, or is not, indicated, to free it from as much danger as possible, to localize, and limit the operative trauma, and finally to render the operation comprehensive and complete.

DISCUSSION.

Dr. James B. Bullitt, Louisville: *Mr. President*—In getting on the floor to discuss this paper I feel very much as a candle might feel, if a sensitive object, on being lightened in midday and held up to face the bright sunlight. By that I mean to say that Dr. Leonard's experience has been so very great and mine so very small that I feel that I am not the one who should open the discussion on this very excellent paper. It has, however, fallen to me to do so and I would like to begin by saying what I conceive the profession of America owes to Doctor Leonard in the matter of differentiation of kidney

stones by means of the X-ray. Not only was he one of the first men in America to call attention to this possibility, but he also has been its chief exponent and, I believe, its most successful exponent. And no matter what the experience of other men may have been, yet we have to acknowledge that few others have been able to obtain his results, a statement that is absolutely unquestionable and incontrovertible. It is the result of the individual operator and not of a method.

I believe that there can be but two classes of people who might for one minute attempt to dispute the value of this particular application of the X-ray. One is the surgeon, who unfortunately is still in existence, who is inclined to decry the use of the X-ray because he does not have it at his own disposal, because of his disinclination to give the matter his personal attention. Therefore he contends that by older methods of diagnosis equally valuable results can be obtained, and that much of his diagnostic skill and acumen will be lost by the fact that he simply turns his patient under a machine and fails to use the powers of observation with which nature has endowed him and in the cultivation of which he has spent much time and money, in fact, the greater part of his life. The surgeon is in imminent danger of ignoring among the proper methods of diagnosis this one method which at once would seem to limit possibilities. Just so the abdominal surgeon oftentimes opens an abdomen to make an easy diagnosis when, perhaps, if he had used all the means and methods of diagnosis which are at his disposal he could have arrived at a very reasonable and very probable diagnosis without the intervention of the abdominal operation. This possibility of abuse, however, does not for one moment invalidate the value of the method.

The second class of men who might say that this method did not have special value is the class, which has not succeeded in attaining these results. I remember being shown an apparatus and on making inquiry whether the apparatus could make good skiagraphs of stone in the kidney, the exhibitor said it could not nor could any other machine. This is the view that some may have been inclined to take because they

could not succeed. If I cannot get any results no one else can, and, therefore, the published results of others are open to doubt.

My own experience with this particular method has not been very encouraging. I have never succeeded in differentiating a stone in the kidney which could not have been easily differentiated, perhaps, by means of the Rœntgen ray; in other words, a stone of distinct and decided density. That fact, however, does not keep me from saying that I am satisfied of the value of this method and of the power of good men to differentiate very small stones and stones of very little density. I have seen some plates which Dr. Leonard made some years ago showing some extremely small stones in the ureter which were passed later and were shown to be composed of almost pure uric acid, a stone which is known to possess little density and therefore is differentiated only with great difficulty. Yet the shadow was quite distinct on the plate.

The value of the method is quite incontrovertible. The surgeon who has had three cases to him and is not satisfied as to his diagnostic ability without the use of the X-rays, is best able to appreciate, perhaps, the value of this method, I myself have had one opportunity of observing that it would be quite possible to open a kidney and remove one or several stones and yet leave behind another stone which would make the operation practically useless.

The case I refer to was one where the kidney was removed because of its destruction owing to the presenc of calculi for a long time. The case was such a flagrant one that the clinical diagnosis was easy and palpable without the use of the X-ray. The kidney was found to be destroyed completely and a nephrectomy was done. On opening the pelvis of the kidney I found several stones but left them there for purposes of demonstration as I wished to exhibit the kidney before the Louisville Surgical Society. But before doing so I experimented to see what I could do with the X-ray. I made a number of exposures of the kidney putting before it some dense tissues like uterine fibroid tissue, liver, etc. I also had the tube at different degrees of penetration to observe the result. You can imagine my surprise when I learned from

the skiagram that the kidney contained another stone which was located high up in a calyx and which has escaped observation while searching for the stones. I have no doubt that if this kidney had been savable, and if operated on by the great majority of surgeons, that this third stone would have escaped detection, and the result would have been an operation that would have been useless.

A. D. Bevan, of Chicago, reported a case of this kind occurring in a patient in whom a nephrotomy was done and a second stone was found afterward in a radiograph made of the kidney. Dr. Leonard has reported some cases, and doubtless many men all over the country have observed cases of this kind. The possibility is a very decided one If the technique of the X-ray operator is sufficient this possibility can be eliminated entirely.

It seems to me that Dr. Leonard's work has shown us a fact which has never been recognized before, and that is, the amazing prevalence of kidney stones presenting symptoms of stone in the ureter. In 89 cases the stones were found in the ureter in 60% of the cases, which to me is a very surprising percentage of cases of stone in the ureter. Not only is this of extreme value, but the fact that it is possible by this method to observe these stones, to observe their advance, to know whether or not it is possible, or probable that the stone will be advanced along the natural channels, whether or not it will be extruded from the body through the urethra, is a matter of the very greatest importance, because it will be absolutely unnecessary and oftentimes disastrous to operate on such cases when we know that the stone, by natural causes, would seek its own outlet into the world.

In making his skiagraphs, Dr. Leonard has always insisted, and in that differs from many who are present today and from writers on this subject, that the tube should be of a certain character so that the differentiation of the shadows produced would be of such a nature that the shadows of tissues of less density than the stone itself would be demonstrable on the plate. Many men have held that this is not so; and yet when we stop to think for a moment, perhaps, that the best

comparison with this kind of light is the light that is projected through the microscopic slide, we must acknowledge that this is true. Many of the objects on the slide become visible to the eye only when the light is so far reduced as to permit the shadow of these objects to fall upon our visual field, because that is allowed to illuminate the field these shadows of lesser density are not visible, but as soon as the light is shut down, they become visible. When the light is full it gives no contrast with the surrounding tissues. Of course, the photographic comparison is not nearly so true because there other conditions come into play.

DISCUSSION.

DR. HENRY HULST, Grand Rapids, Mich: Every one is familiar with Dr. Leonard's work and we ought to be proud of what he has done in this line. Like most of us I too have tried to do a little something in the way of skiagraphing kidney stones. In the small cities the material that presents itself is, of course, not so great as in the larger cities. However, nearly every skiagrapher will at some time or other have the opportunity to ray for kidney stones, and unless he has given the matter thought before hand he will be in doubt as to just how to go about it. It is a very difficult problem.

I have tried several methods, but have finally come down to using one that I have in part copied from others. It consists, first of all, in cutting out the secondary rays that are so very apt to have a disturbing effect on a dry plate. Of course, this can be done with an ordinary diaphragm, but in order to lessen as well the distance between the anode and the plate, and to diminish the distance that the ray must travel through the body tissues, I resort to compression of the body.

Caldwell, in his book, shows a way of doing that by placing weights on the abdomen so as to flatten it out; but that seems to be a rather crude way. Albers-Schönberg, of Germany, constructed a compression diaphragm and I tried to get one like it in this country but failed. So I had a mechanic in Grand Rapids make a compression diaphragm for me by

means of which I squeeze the patient and cut off the secondary rays. In this way I get results that I cannot get in any other way. It is efficient not only for taking skiagraphs of kidney stones, but can be used to advantage in all other parts of the body as well. In the last number of the "Fortscritte auf dem Gebiele der Rœntgen Strahlen" is mentioned a little trick which may help us in skiagraphing for these stones. I do not know whether Dr. Leonard uses the method. But it is very simple. It consists of inflation of the colon by means of air. It is a very useful method, and in the case of large subjects I would advise you never to fail to inflate the colon with air. Then use the proper diaphragm, make the proper exposure, and it will not make much difference whether the tube is high or low. Of course, the tube should not be either too high or too low; the rays must penetrate; with a given penetrator the time depends upon the current used. We need not have a tube possessing any particular penetration when we can modify the other factors.

I always test the penetration of my tube before I use it. I can do this accurately by means of the Walter skiameter. A tube that will penetrate through six openings of the skiameter I consider a fit tube for a heavy subject. For a small subject a Walter 5 would, perhaps, be better. I consider it safer to use a soft tube and expose longer, than to use a tube too high for the inductorium. But I do not believe it is necessary to use a low tube if you will modify the other factors. If you can prevent fogging of the plate by means of diaphragms, then you can use any tube, although that would not be good economy.

For kidney stones I use a Queen's 18 inch coil, and I expose about 2 minutes during suspended respiration. This is the ideal way for kidney stones as well as for gall stones which are much more difficult to skiagraph.

Dr. Leonard. Closing the discussion:—It would be rather difficult to go into a discussion of the technique of this subject at this time. I will say, however, that my technique is the very simplest possible. I place the patient in the recumbent position and elevate the head and hips so that there

is a flexion of the spine that brings the lumbar region in close contact with the plate. The tube is placed at a distance of about eighteen inches from the body. I do not use any diaphragm or any other apparatus; no compression of the body or inflation of the colon or anything else. The flexed position prevents motion in the abdomen. I make an exposure with a tube which on my apparatus has a resistance of from 1½ to 2 inches parallel spark gap. Of course, that means on the apparatus that I am employing because the quality of the X-ray depends on the individual apparatus and the operator's method of using that apparatus. They are a law unto themselves. Then, too, we find that equally good results are produced with both the high and the low tubes, a fact that cannot be harmonized.

If I have a patient with a little thicker abdomen than usual, then I simply raise the tube and increase the vacuum to 2½ inches measured by a parallel spark gap. I never go beyond that.

Dr. Hulst spoke of the plentifulness of material about Philadelphia: I must say that most of my cases come from the outside and not from Philadelphia.

It certainly is true, that ureteral calculi are more numerous than has hitherto been supposed, and it is equally true, that it is neither necessary nor a safe procedure to operate on every patient who has a calculus in the ureter.

TWO CASES OF SEVERE X-RAY NECROSIS, PRESENTING SOME UNUSUAL FEATURES.

BY CLARENCE EDWARD SKINNER, M.D., LL.D.,

Of New Haven, Conn.

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Mr. President and Members of the American Roentgen Ray Society—During the past two years our attention has been forcibly attracted, and more or less exclusively occupied, by the gross, general, therapeutical influences of the X-ray. The present time, however, is bringing with it a demand for special knowledge concerning these influences, and their evolution, *modus operandi,* and detail, constitute fruitful fields for future research. Clinical observation will designate the problems; physiology, pathology and physics must solve them. The cases following suggest some queries and food for thought in this connection.

The first was observed upon a woman fifty years old, of the brunette type, who was under X-ray treatment for pseudoleukaemia accompanied by a large accumulation of fluid in the abdomen. The glandular enlargements were very prominent in the abdominal cavity, particularly on the left side, and in the cervical, axillary and inguinal regions. The X-ray applications were all made to the abdomen, the tube focused about two inches to the left of the median line, but so arranged that all of the regions affected received some of the radiance. No shields were used except over the face, and only a thin towel was interposed between the skin and the source of light. The tubes used were of the German type with divided anodes, forced back a spark of from four to eight inches, and produced rays of high penetration; distance of anode from the patient's skin, ten inches; time of exposure, fifteen minutes; exciting apparatus, twelve revolving thirty-two inch plate, Morton-Wimshurst-Holtz influence machine for the first three months, and a sixteen revolving thirty-two inch plate machine of the same type thereafter.

From July 26th, 1902, to December 4th, 1902, she received fifty X-ray treatments, being an average of one every 2.6 days. From December 4th, 1902, to April 3d, 1903, she received twenty-five treatments, an average of one every 4.7 days, or about half as frequently as during the preceding period. At this time her disease had improved to such an extent that it was considered safe to interrupt the treatment for a while, which was done. During the period that she was under the above-described treatment the skin over the exposed region of the abdomen had repeatedly become heavily pigmented and peeled off exposing healthy pink skin underneath. Twice there appeared a slight erythema with itching and burning, which subsided completely in five or six days upon suspending the applications. As far as the effect of the X-ray was concerned everything seemed to have eventuated most happily up to that time.

I was asked to see her again April 30th, and found her suffering severely with sharp, cutting pains in the anterior abdominal wall and streaking up under the ribs nearly to the shoulders on both sides. The skin of the abdomen had been darkly pigmented but now a dusky redness showed through the brown, over an area of about six inches in the vertical by ten in the lateral diameters, and a very intense burning sensation was torturing the patient constantly. Various ointments and lotions were applied without securing relief, and it became necessary to resort to morphine in a day or two. The condition progressed from bad to worse until May 13th, at which time an area four inches in the vertical by eight in the lateral diameters presented the typical picture of white gangrene, the dead tissue being yellowish-white in color, of a tough and leathery consistence with the characteristic gangrenous odor. Severe shooting pains were present almost constantly, and manipulation of the parts provoked paroxysms of the same lasting for several minutes. Pulse ran from 105 to 115 beats per minute, the temperature varied from 100°F. to 102°F., and the patient was unable to leave her bed because of the severe general prostration. Her appetite was excellent and continued so throughout the entire course of the illness.

From this time on the dressing consisted of irrigation with normal saline solution followed by a ten per cent. aristol and lanolin ointment twice daily. At this time also the edges of the

slough began to separate, and this process progressed steadily until June 9th, when it was completed by the exfoliation of the central mass, which was three-quarters of an inch thick by actual measurement. Synchronously with the completion of the sloughing process was observed cessation of the sharp shooting pains, and they did not recur. The edges of the ulcer had begun to heal as soon as the separation of the slough commenced, but this process was very sluggish and unsatisfactory, and on July 9th, 1903, I commenced using the continuous electrical current, negative polarity, seventy-five volts and five to ten milliamperes for ten minutes applied through a bare metal electrode in direct contact with the ulcerating surface, three times weekly. This hastened the healing process very noticeably, and the ulcer was completely covered with healthy skin by October 1st, 1903.

By the middle of July the epithelial layers of skin covering the apparently healthy areas contiguous to the ulceration, and which had been deeply tanned by the rays, had peeled off entirely, leaving exposed newly formed, epithelial layers, pink, soft, and entirely normal in appearance. Two weeks later this tissue had become pigmented and by the middle of September it was as deeply browned as was that which had exfoliated. At this time there was also observed, scattered over this newly-formed cuticle, twenty-five or thirty wart-like excrescences, varying in size from a mere point to five or six times as large as a pin-head. In this connection I should like to call your attention to the fact that no exposures to X-rays had taken place for more than five months preceding, and that since the last exposure the epithelium which had borne the brunt of the treatments had completely exfoliated, its place having been taken by newly formed tissue, apparently unmodified in structure.

Early in September, or five months after the last X-ray treatment had been given, the skin began to break down at a point three inches to the left of the median line and the same distance above the superior border of the original area of ulceration, and spread over an area of three by five inches during the next month. This area became one of typical white gangrene almost at once, but did not extend more than one-third of an inch in depth. The management used upon this spot consisted of saline irrigation twice daily, followed by dusting with a powder consisting of equal

parts of anesthesine and talc which controlled the pain perfectly. About half of the slough has now completely separated, leaving a healthy granulating surface which is slowly healing. I shall apply the continuous electrical current for its accelerating influence upon the reparative process as soon as the rest of the necrotic tissue has exfoliated.

The noticeable features about this case were as follow:

First, the depth to which the original necrotic process extended.

Second, the "tanning" and excessive proliferation in spots of the epithelium of the new skin that was exposed by the peeling of that which had been browned directly by the ray, which new epithelium had not been exposed to the ray and was apparently entirely normal in color and structure when it first developed.

Third, the cessation of the pain as soon as the necrotic tissue had completely separated.

Fourth, the favorable effect of the galvanic current in hastening the healing process after the necrotic tissue had sloughed off.

Fifth, the appearance of an area of necrosis five months after the last X-ray application, in a region which had previously exhibited no evidences that such injury had been inflicted.

Sixth, the happy effect of the anesthesine and talc mixture in relieving the pain of this last mentioned ulceration.

The second patient, a medium blonde with gray eyes and dark brown hair, aged forty-nine years, came to me for X-ray applications to an inoperable malignant process in the neighborhood of the left broad ligament accompanied by marked ascites, on January 27th, 1902. From that date until April 4th, 1903, she received one hundred and fifteen X-ray treatments, an average of one every 3.7 days. The technique was the same as had been used in connection with case 1, except that the twelve-plate static machine was used upon this patient for the first *nine* months. At this time her condition as regards improvement was such that it was considered safe to discontinue the treatment tentatively. While undergoing the treatment the skin over the exposed region had repeatedly become heavily pigmented and peeled off exposing underneath soft, pink, new skin. Three times there had obtained slight erythema with itching and burning which had subsided kindly upon suspension of the treatments. When the final treat-

ment was given on April 4th, 1903, the skin was deeply tanned and felt to the touch dry and brawny, and this latter characteristic seemed to extend for some distance into the subcutaneous tissues.

There was nothing apparent in the condition to indicate that a dermatitis was about to manifest itself, not even an erythema, but there was present at this time a phenomenon that I had never before observed in this connection, consisting of a subcutaneous effusion of blood about as large as a nickel five-cent piece, two inches to the right of the median line and about an inch above the level of the pubis. This area was slightly depressed below the level of the surrounding tissue, was slightly sensitive to the touch, and had developed suddenly two or three days before.

The spot became more and more sensitive. In a few days sharp pains appeared in this region and streaking upwards to the ribs, which increased in severity until by the first of May they had become pretty constant and so severe that the internal administration of opiates was demanded, and the area defined by the subcutaneous effusion of blood had become gangrenous. The body temperature ranged from 99.5°F. to 101°F. and pulse from 95 to 105 beats per minute. The necrotic area gradually increased in size until by the middle of May it was as large as a silver dollar. At this time another hemorrhagic effusion as large as a silver quarter of a dollar appeared on the left side of the median line which became necrotic about the first of June. By the first of July these areas had coalesced at their lower borders through an isthmus three-quarters of an inch in width, the necrosis having been preceded by little scattered subcutaneous effusions of blood as had been the case with the other lesions. The affected regions were covered by the same tough, mal-odorous, yellowish, fibrous tissue described in connection with case 1, and had at this time reached their maximum size, consisting of a circular spot on the left side two inches in diameter, and on the right side an irregular spot two inches in the vertical and three in the lateral diameters. As I have just stated, these areas were connected at their lower borders by an isthmus of necrotic tissue three-quarters of an inch in breadth, which dimension subsequently increased to one and one-half inches.

By this time the epithelial layer of the skin covering the adjacent, apparently uninjured regions, and which had been deeply

tanned by the rays, had exfoliated and the newly-formed tissue which took its place was normal, soft, and pink in structure and appearance. In a few days, although no exposure to X-rays had taken place, it became harsh, dry, and profoundly erythematous with considerable itching, but showed no fresh pigment deposits, and has remained in that condition ever since.

The long-continued severe pain had greatly impaired the patient's general condition, and she was admitted to the sanitarium where she could be more efficiently treated on July 8th, 1903. To make a long story short, we ran through the list of pain-relieving applications, including the anesthesine and talc mixtures which, by the way, made the pain worse in this case, and none gave any satisfaction except the ice cap placed over the ulceration, and an ointment consisting of lanolin with enough olive oil to soften it and ten per cent. of powdered opium. The application of this twice daily preceded by saline irrigation was the management finally adopted.

I used the galvanic current as with case 1, in the hope that it would hasten separation of the necrotic tissue but without result, and the necessary manipulation of the parts was so painful to the patient that the procedure was finally abandoned.

The sloughing of the necrotic tissue progressed very slowly and was not complete until early in October, but the disappearance of the last fragment was accompanied, as in case 1, by the disappearance of the severe pains. The necrosis extended to the depth of about three-eighths of an inch, and a healthy granulating surface was left which is healing very satisfactorily under applications of the continuous electrical current, as described in connection with case 1, which I began using five weeks ago.

Early in October, or six months after the last X-ray treatment had been given, there appeared another slight subcutaneous hemorrhage the size of a dime, three inches to the left of the median line and two inches above the upper border of the original ulceration. Ten days after, the characteristic necrosis appeared which sloughed in two weeks, and the resulting ulceration was completely covered by healthy skin by the last of November. None of the severe pains accompanying the development of the other necrotic foci obtained with this one.

The noteworthy features about this case were as follow:

First, the constant appearance of a subcutaneous effusion of blood in the areas which subsequently became necrotic.

Second, the spontaneous development of profound erythema and structural modification in the newly-formed skin exposed by the exfoliation of that which had been browned by the direct agency of the rays.

Third, the cessation of pain as soon as the necrotic tissue had completely separated; a feature also exhibited by case 1.

Fourth, the apparent failure of the direct electrical current to accelerate the separation of the necrotic tissue, and its gratifying effect upon the reparative process after this tissue had sloughed.

Fifth, the appearance of an area of necrosis six months after the last X-ray application, in a region which had previously exhibited no evidence that such injury had been inflicted; a feature also obtaining in case 1.

Sixth, the aggravation of the pain produced by the anesthesine and talc mixture.

Although neither of these cases presents a finally completed history, what has been observed to date is sufficient to shed some additional significant light upon the influences which the X-ray exerts upon tissues, and the management of the untoward results of these influences.

First, the belief, somewhat extensively held, that a patient who "tans" well need not fear a burn, is demonstrated by these cases to be untenable. Both of these patients tanned readily and profoundly.

Second, the "tanning" and excessive epithelial proliferation of the new skin observed in case 1, and the profound erythema and structural changes of the new skin observed in case 2, all of which modifications obtained in tissues which had developed months after exposures to the rays had ceased, indicate that the physiological action of X-light is not confined to stimulant or destructive influence upon tissues that already exist, but that it is capable of modifying most profoundly and more or less permanently, the developmental functions which control cell growth. I have previously expressed a belief in this phase of influence, and that we shall ultimately find that it plays no small part in the beneficial effect exerted by the X-ray upon many cases of malignant growths.

Third, the abrupt cessation of the sharp cutting pains simultaneously with the final separation of the necrotic tissue, would point to direct irritation by the sloughing mass, of the distal ends of nerve trunks supplying the affected parts as their exciting cause, probably through the development of toxins by retrograde tissue metamorphosis at the line of separation: a pure neuralgia in short, and which would indicate extirpation of the necrotic area by curettement or otherwise as a logical management for X-ray dermatitis of this degree.

Fourth, the accelerating influence of the continuous electrical current upon the process of healing after the slough had separated, noted in both cases, is significant from a therapeutical standpoint. The power of the negative pole of the continuous electrical current to hasten repair in open sores of various sorts has long been known to electro-therapeutists, but the X-ray ulceration has exhibited a peculiarly intense resistance to all ordinary measures available for this purpose, and the knowledge that we have in this modality an effective curative agent even in this condition constitutes a comforting thought. It is probable that skin grafting will be avoidable in many cases where galvanism is available.

Fifth, the appearance of new areas of necrosis, in case 1 five months, and in case 2 six months, after the last X-ray exposure had been made, admits of three hypotheses in the way of explanation. It might have been due to a cumulative characteristic of the ray, whereby the direct effect of the exposure did not fully develop until after these lapses of time; it may have been due to a modifying influence exerted by the ray upon the developmental functions of the cells involved, whereby the younger generations of cells were unable to acquire the degree of vitality necessary for the maintenance of tissue integrity; or it may have been the indirect result of circulatory insufficiency caused by an X-ray endarteritis obliterans which had required this length of time for its full development. None of these are entirely satisfactory, however, and we shall have to await the acquisition of a fuller knowledge of the *modus operandi* of X-ray effects, before we can decisively account for this, and many other of its vagaries.

Sixth, the sedative effect of anesthesine upon the pain in case 1, and its aggravating influence in case 2, illustrates the statement frequently made and the truth of which is now pretty generally

admitted, that no two cases of X-ray pain can be depended upon to react uniformly to the same palliative agents. In no other condition does there obtain so emphatic an exemplification of the old adage that "What's one man's meat is another man's poison." Each case must be treated on its own individual peculiarities, and usually the only way to ascertain the peculiarities is to begin at one end of the list of therapeutical agencies and apply them successively until we find one that is effective.

Seventh, the sudden and constant appearance of subcutaneous hemorrhage preceding the development of necrosis noted in case 2, is worthy of record, but I do not at present comprehend its significance, nor can I offer a satisfactory explanation.

In conclusion, gentlemen, the histories to date of these two cases, constitute a warning against exposing a patient to the X-rays with even a moderate degree of frequency through long periods of time, no matter how well they seem to bear them at first. There are few conditions so pregnant with torture for the victim as a deep X-ray dermatitis, and the risk of precipitating such a disaster is only justifiable in cases presenting an absolutely hopeless prognosis under other methods of treatment.

As bearing on the matter which I have just been discussing, more particularly as to whether or not the physiologic influence of the X-ray exhibits as one of its elements the power to modify the developmental processes involved in cell growth, I will read an extract from a letter that I received from Dr. C. H. Fessenden, Newton Center, Mass., the day before I left New Haven.

"*My Dear Dr. Skinner*—I have just met with a new feature in X-ray results which I have never seen reported. I told you of my case of cervical adenitis which was cured in the early summer. The young lady came to see me yesterday unprofessionally. The gland was about normal in size and has remained so through a recent febrile attack. The anomaly is this, that from the lower margin of the hair, extending down for some inch or more along the posterior border of the sterno-cleido-mastoid is a new growth of hair which began to appear in the summer and is now an inch and a half or more in length. Also on the cheek on that side—although I had screened with a lead plate—the hair is noticeably more vigorous than on the other side of the face.

"All my treatments were with a high tube at one foot for about fifteen minutes, and at no time was there any reaction other than the almost immediate blush which appeared after treatment."

The feature of the case to which I desire to call your attention is the abnormal growth of hair back of the sterno-cleido-mastoid and below the limit where the hair usually grows. This location is normally devoid of any but the most elementary of hair structures, and the fact that a growth of hair one and a half inches long was produced by the X-ray upon a portion of the skin which is normally devoid of this structure would indicate that modification of cell development, in some conditions at least, forms a prominent element in the physiological influence of this agent.

DISCUSSION.

DR. WILLIAM S. NEWCOMET, Philadelphia: I was asked to see a lady who was being treated with the X-ray for an epithelioma of the forehead. She was eighty years old and had been quite bald. The epithelioma was not doing well under the treatment, but a most profuse growth of hair covered the whole front of the former bald spot and becoming thin as it extended back on the head.

DR. HENRY K. PANCOAST, Philadelphia: I have been treating a case of a very large epithelioma of the chest wall for over a year. His beard was entirely destroyed over his chin. He then stopped coming to the hospital for a while, but several months afterward he came back, and on his chin he had a very heavy growth of hair, better than he had had before.

I can say from my own experience with the X-ray that at one time when in the habit of sitting down near the tube while it was excited, with one side of my head always turned toward the tube, the hair came out, and I did not have half as much hair on that side as on the other. Since then the hair has grown again and is now as thick as ever. I have heard of similar instances.

DR. G. P. GIRDWOOD, Montreal, Can.: I have had several cases where the hair was burned off by the treatment with the X-ray, but the hair grew in again, but instead of being perfectly straight, as it was before we began the treatments, it came in curly.

I have been bald for many years, but since I have taken to the X-ray my family tells me that my hair is growing again.

DR. JAMES B. BULLITT, Louisville, Ky.: I wish to report an unusual case of necrosis very much along the line of the cases reported by Dr. Skinner in that it was manifested several years after the primary injury had been sustained. A young man undertook to go into the X-ray business and make apparatus. He made a number of exposures of his own face and head in the effort to determine just what his apparatus could do. Before he was aware of it he had a very decided burn of the right side of his face, and he lost all the hair on the side of the face and head. This was followed by a very large area of necrosis. I think Dr. Leonard will remember seeing this young man because he came to Philadelphia for the purpose of consulting the Doctor.

The young man quit the X-ray business, and he told me that about a year afterward the ulcers healed, but he began to have trouble with his teeth. An abscess formed at the roots of every one of his teeth on that side of his face, one after the other, and his dentist had to open up the abscesses and allow the pus to escape. The dental nerve evidently had been destroyed.

It seemed to me to be a very unusual and remarkable effect of the X-ray, one that it is well to bear in mind when we are giving X-ray treatments.

DR. CHAS. WARRENNE ALLEN, New York City: A rather remarkable case suggests itself to me by the remarks just made, one which I should hesitate to mention in a mixed society; but here, where you all know the possibilities of the X-ray, I feel myself compelled to tell you about this case.

An old gentleman, aged about 72, was suffering from melancholia, and a part of his complaint was a very severe pain in the head. After a number of exposures to the scalp, given with the view of decreasing this pain in the head, I noticed a decided growth of hair where he had not had any when he first came to me. And it came in wiry and with a tendency to become curly. It not only grew up straight, but it turned over at the tip so as to make a hook-like end of each hair. As he was well along in years, and was not possessed of any vanity, he had his hair cut, but re-

marked that were it not for his more serious trouble he would feel quite proud of this development so late in life.

DR. R. H. CUNNINGHAM, New York City: At various times during the past year I have been investigating this subject from a scientific standpoint, and have had some interesting and peculiar experiences. My experiments were made upon a number of white mice, which were placed in four small square wooden boxes, partly or completely covered with aluminum foil. The boxes containing the mice were arranged as follows during the exposure to X-rays: Box No. 1, covered with aluminum on the top and the upper third of its sides rested upon an insulating plate of hard rubber. No. 2 was arranged similarly to No. 1, except that the foil was attached to a well grounded conductor. No. 3, covered with foil on the top and sides, rested upon a grounded metal plate, although the bottom of the box was insulated from the plate by a sheet of vulcanite. The metallic sides of the box were also grounded by means of a small wire connected to the plate. Box 4, completely covered with foil, was arranged with its metallic bottom in good contact with the grounded plate. The mice were exposed to tubes of various degrees of penetration. The mice in box 3 that were exposed with a ground plate beneath and the aluminum screen partly covering the box always received the worst burns and they were peculiar. We got first a burn on the head and back, shown by loss of hair and dermatitis followed by loss of tissue. After several days another burn developed beneath the chin and belly. The mice in the ungrounded box received very slight burns; whereas, the mice in the grounded box completely covered with foil had in all about fifty hours' exposure, suffered no burns and I propose to use them in the next series of experiments. That they were subjected to X-ray actions of various kinds was demonstrated by the fluoroscope. As the mice were exposed at the same time all were subjected to the same kind of rays. I will not go into an explanation of this phenomenon as it would be going into the subject too deeply. All of us know that Tesla has claimed that the aluminum screen placed between the patient and the X-ray tube protected the former from burns, but it does not. So far as I know no one has ever succeeded in burning a patient or animal inside of a grounded aluminum box because there we have

absolutely no electrostatic action. With the arrangement described in connection wth box 3, where the electrostatic activity was evidently the greatest, the harmful results were manifestly more pronounced, for after an exposure of 35 minutes under such conditions the mice were usually so badly burned that death resulted in four or five days.

DR. MIHRAN K. KASSABIAN, Philadelphia: I, too, am the victim of X-ray burns affecting my hands. I received it in a most peculiar manner. Adjacent to an operating room I have another room in which I perform my examinations, and often I would go into this room while my tube was excited treating patients. I had a habit of leaving the door leading to the operating room partly open, and every little while I would stick my head around the door in order to see what was going on—to see whether the tube was properly excited and the patient in good condition. In this way I exposed my hands and face, and as a consequence I am suffering with a very severe burn of the hands since five years, and a very heavy, rough tan on my face, and lately conjunctivitis, neuralgic pains on the same side of face and arm.

PROF. A. W. GOODSPEED, Philadelphia: I am quite convinced that some of the effects observed from the action of the X-ray are due to a secondary action of the walls of the room and of the air and the vapor in the room. It has been demonstrated beyond question that everything in the field of the X-ray tube is secondarily active and sends off rays which have some of the characteristics of the X-rays, although not all of them. I think it very likely that some of these seemingly indirect effects are due to this secondary radio-activity of the room and its contents.

LOCATING FOREIGN BODIES BY THE ROENTGEN RAY.

BY DR. WILLIAM M. SWEET,

Of Philadelphia, Pa.

All accurate methods of localization of foreign bodies by the Rœntgen rays are based upon the triangulation of the shadow of the body from two or more exposures with the tube in different positions, and studied in relation to one or more known points upon or at a known distance from the external skin surface. The fixed points from which the measurements are made may be small lead discs or fuse wire held in contact with the skin by adhesive plaster, or by ball pointed steel rods which rest against the skin, or are at a known distance from the part containing the foreign substance.

For the past six years the writer has employed the principle of triangulation in the location of foreign bodies in the eyeball, and the knowledge gained of the size of the metal and its exact location has undoubtedly resulted in preserving many eyeballs that otherwise would be lost. A special form of apparatus has been employed in the work, which combines a holder for the photographic plate with ball pointed indicating rods as fixed points of measurement. The apparatus is supported at the side of the head, and the indicating rods are adjusted so that one is opposite the centre of the cornea, and the other is at a known distance to the temporal side of the head. The indicators while freely adjustable are always parallel with each other and with the plate, and the two balls are perpendicular and 15 mm. apart at their centres.

In employing the apparatus the distance of the centre ball from the corneal summit is measured, and the eyes are fixed on a distant object, so that the visual axes are parallel with the photographic plate. Two radiographs are made, one with the tube parallel or nearly so with the plane of the indicating rods, and the other with the tube at any distance below this plane. These two radiographs show the shadow of the foreign body

and that of each of the indicators. Knowing the distance of the indicating rods apart, and the distance of one of the balls from the centre of the cornea, the position of the metal in the eye may be readily determined, since the shadow of the body preserves a fixed relation with respect to the shadows of the indicating balls in whatever position the tube is placed.

The position of the foreign body in the eye from the two radiographs may be found by employing threads to indicate the lines of shadow at the two exposures, although greater accuracy is probably secured by making the measurements on a flat surface, with circles to represent horizontal and vertical sections of the eyeball. A printed chart is convenient for this purpose, on which the position of the indicating balls at the two exposures is marked.

Upon the circle, representing the vertical section of the eye, is indicated the distance of the shadow of the foreign body, that is above or below the shadow of the two indicating balls, and a line drawn through the points for each radiograph. The crossing of these lines of shadow represents the position of the foreign body as measured above or below the centre of the cornea.

To determine the distance of the metal back of the corneal summit, one of the radiographs is taken, and a measurement made of the distance the shadow of the centre ball of the apparatus is back of that of the external ball. This is entered above the external ball on the horizontal section of the eye. A line drawn from this point through the centre ball and continued to the distance the tube was away when the exposure was made gives the direction of the rays. If the distance the shadow of the foreign body is back of the shadow of the external ball is entered above the spot representing the external ball on the diagram, and a line drawn from this point to the spot representing the situation of the tube, it will represent the line of shadow of the foreign body. Where a line perpendicular to the position of the foreign body, as shown on the vertical section of the eyeball, intersects this line, is the situation of the metal as respects its distance back of the anterior portion of the eyeball.

LOCATING BULLETS OR OTHER LARGE BODIES.

A larger apparatus is employed for the localization of bullets and similar substances situated in other parts of the body. Although differing in its construction from the eye localizing apparatus, it is based upon the same principle of the crossing of the planes of shadow of the foreign substance at two different exposures.

The localizer consists of a firm base, the top of which is covered by sheepskin and crossed by two steel wires at right angles to each other. A sliding drawer at one side permits

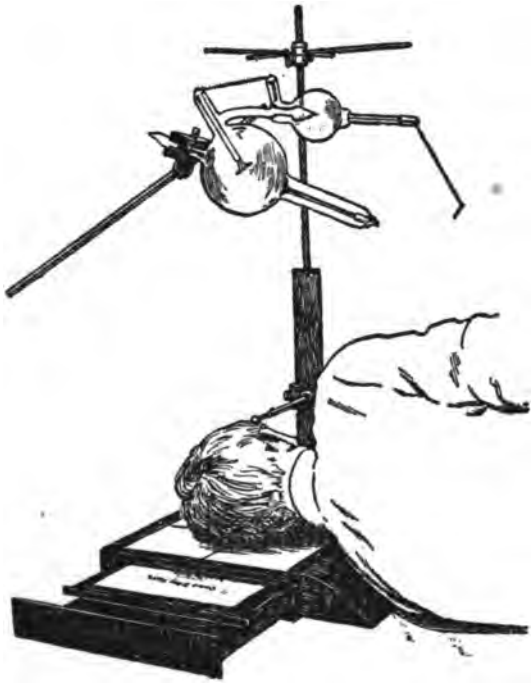


Fig. 1. Localizer, Showing Receptacle for Plate.

changing the photographic plate without disturbing the position of the patient. Resting upon this sliding drawer is a platform upon which the plate rests. As the drawer is pushed in, the plate is carried firmly against the bottom of the sheepskin and close to the patient's skin.

Upon the side of the apparatus is a support to which is attached an upright graduated bar, upon which slide three rods. The two upper rods are employed to indicate the position of the anode of the tube at the two exposures, while the lower rod has a pointed extremity, over which slips the indicating ball. The centre of the indicating ball is directly above the crossing of the wires on the base, and its height is shown by the scale.

The head or other portion of the body containing the foreign body rests upon the sheepskin top of the apparatus, the cross wires previously inked leaving a mark upon the skin. The indicating rod is then lowered until the ball rests upon the skin, and this spot is also indicated with ink. The distance of the ball above the cross wires is then read from the scale on the upright.

The tube is placed from eighteen to twenty inches from the plate, either directly above or to one side of the indicating

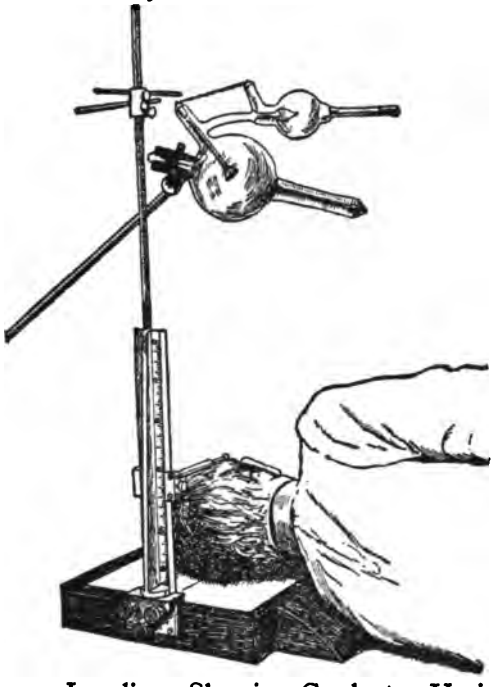


Fig. 2. Localizer, Showing Graduator Upright.

ball, and one exposure made. A second plate is exposed with the tube at the same height, but from four to six inches to the right or left of the first position. The exact position occupied by the tube at the two exposures is not determined, since it is readily found from the plate by noting the place of shadow of the indicating ball. A measurement must be made, however, of the distance of the anode of the tube from the photographic plate.

After development the radiographs show the shadow of the cross wires of the apparatus, the indicating ball, and the foreign body. These three points on each plate are now marked upon a sheet of celluloid, the point of crossing of the wires corresponding to lines upon the celluloid sheet. This sheet is placed upon the top of the apparatus, the point of crossing of the lines corresponding to the junction of the cross wires on the sheepkin. The indicating rod (x) is placed at the

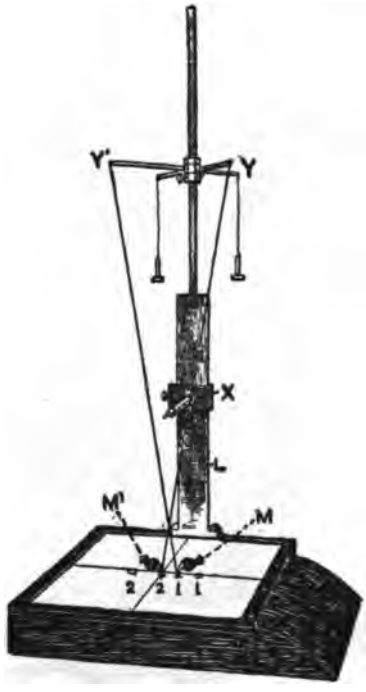


Fig. 3. Localizer, Showing Method of Using.

height it occupied at the time of exposure of the plates, and the ball removed, exposing the pointed end of the rod, which corresponds to the centre of the ball. A thread is now passed from the shadow of the indicating ball at the first exposure, touching the point of the indicating rod, and continued the exact distance that the anode of the tube was away at the first exposure. This line represents the direction of the rays casting a shadow of the indicating ball. A second thread is similarly passed from the spot representing the shadow of the indicating ball at the second exposure, touches the point of the indicating rod, and continues to the distance of the tube. These two threads indicate the direction of the rays casting shadows of the indicating ball and also the position of the tube at each exposure (Y^1, Y). If the ends of the threads resting upon the points representing the shadow of the indicating ball on the transparent celluloid are moved to the spots indicating the shadows of the foreign body, their point of crossing will give the position of the body in reference to the indicating ball and the cross wires. The distance of this point from the indicating ball represents the location of the foreign body in the tissues as measured from the ink spot on the skin at which the ball rested at the time of exposure. In a similar manner the distance from the cross wires may be measured, the depth of the body in the tissue determining which of the two measurements will be most useful for surgical procedure.

Both pieces of apparatus were made for me by Queen & Co., of Philadelphia.

DISCUSSION.

Dr. G. P. Girdwood, Montreal, Can: I have used that apparatus for the localization of foreign bodies in the eye. My son has used it even more extensively than I have. I think it is an admirable piece of apparatus and if one will only work according to the rules laid down he cannot fail to find the object either in the eyeball itself or near it. The second apparatus I have never seen before, yet the principle on which it is constructed, for the localization of foreign bodies in any

tissue cannot fail to give you the exact position of the object for which you are searching.

Dr. Sweet (closing the discussion): In reply to a number of gentlemen who have seen illustrations of the apparatus as applied to the head I desire to say that it is intended for the localization of foreign substances in any part of the body. The smaller apparatus is employed exclusively for the determination of the location of foreign bodies in the eyeball or orbit, and is now used in many of the leading hospitals throughout the country. In Philadelphia it is the practice of the leading ophthalmic surgeons to determine by the Rœntgen rays the situation and size of the metal in the eye before an attempt is made to extract it with the magnet. Since this course has been followed many eyes have been preserved with useful vision that would have required removal under former methods of treatment.

SKIAGRAPHY OF THE CHEST.

BY HENRY HULST, A.M., M.D.,

Of Grand Rapids, Mich.

I. *Raison d'être.*

Not to leave a single stone unturned is the part of the good diagnostician. Yet, as a result of training or of peculiarity of personal make up, it is a well-known fact that all-around skill in the use of the various methods of investigation is exceptional.

This fatal tendency to one-sided development, together with the comparative newness of Rœntgenology in internal medicine, may serve to account for both the neglect and the too exclusive employment of the Rœntgen rays in the examination of the chest.

To illustrate: Butler (Diagnostics of Internal Medicine, p. 654), while admitting that "Medical fluoroscopy and skiagraphy have proved their usefulness in diseases of the chest," gives it no further attention, because "The very considerable expense of the necessary apparatus, the technical skill required in its management, and the personal training and experience which is requisite before trustworthy work can be done places X-ray diagnosis for the present in the hands of the expert."

But is it not true that all medical diagnosis is a matter of training and large experience, and has not all knowledge and endeavor come down to us through the hands of the expert?

Such, at least, is implied in the opinion of Musser, the author of another late text-book on medical diagnosis, although he devotes but a page or two to X-ray examination of the chest. Musser says: "The use of the large number of instruments that are essential, and the chemical and bacteriological examinations that are made require a great deal of time. Often the diagnosis is a question of hours or even of

days. The patient profits thereby. The bedside labor is great, and, in addition, he must have a laboratory at his command for microscopical, chemical and bacteriological work. The outcome is that the scientific physician must have a clientele limited in number, or else have one or more assistants to aid him in his investigations. Without doubt the latter will soon occur." (Musser: Medical Diagnosis, p. 21.)

One thing seems certain: Mere considerations of expense and skill cannot prevent the general recognition and ultimate adoption of Rœntgen ray examination in medicine if only "The patient profit thereby." And that he does profit thereby cannot be doubtful if he profits by advancement in diagnosis.

"Die Rœntgenologische Diagnostik der Erkrankungen der Brusteingewerde" of Holzknecht and "The Rœntgen Rays in Medicine and Surgery," of Williams, not to speak of other important contributions to the literature of medical diagnosis, have made it imperative for the phthisio-therapist as well as for the general internist to take cognizance of the light the Rœntgen rays throw upon their subjects and have demonstrated the unwarranted dogmatism of Hilderbrand's assertion that "In doubtful cases of phthisis pulmonalis we may safely spare ourselves the trouble of an X-ray examination."

Arriving at the question of the comparative usefulness of skiagraphy and diascopy, it cannot be denied that the latter admits of a wider application in the examination of the chest. Certain data, moreover, are more accessible to fluoroscopy than to skiagraphy. Thus limited excursions of the diaphragm, which now goes in literature under the name of Williams' sign, is decidedly significant in the diagnosis of incipient phthisis and is best observed by the fluoroscope. Paralleloscopy is the only method for the exact determination of the size and shape of the heart, and the fluoroscope is needed for that. Hence if the choice lay between the two methods I should prefer fluoroscopy. Indeed, a fluoroscopic view of the moving palpitating contents of the chest constitutes at present the nearest possible ante-mortem approach to a post-mortem examination.

Normal Chest

Why then skiagraph the chest at all?

The well-known fact that the photographic plate will show skin eruptions before they are otherwise visible, that therefore, it is more delicate than the eye, is utilized in skiagraphy as it is in dermatology and astronomy. Hence we no longer deem it sufficient to look at a fracture with the screen except for the purpose of general orientation and as a preliminary to a more adequate skiagraphic examination. My reason for skiagraphing the chest is no other, therefore, than that for skiagraphing anything else. That Williams "Is able to detect an abnormal condition of the lungs in early tuberculosis better by means of the screen than by means of the photograph" (Williams, op. cit. p. 120), is not the fault of skiagraphy as such. For general orientation and analysis of the phenomena of motion fluoroscopy is of prime importance, but for bringing out structural detail skiagraphy is far superior, provided the object be at rest. Perhaps this provision was not appreciated as a condition sine qua non by some of the partisans of the fluoroscope. What in case of emergency skiagraphy may accomplish even for recording the phenomena of motion is well shown by the work of Eyckman of Scheveningen, Bewegungs-photographic mittels Rœntgenstrahlen. Fortschritte a. d. Gel. d. Rœngenstr.

By carefully observing this condition of rest, Holzknecht therefore finds, as we should naturally expect, that "A radiogram of the lungs and of the process of consolidation is far superior to the image upon the screen (Holzknecht, op. cit. p.).

Hence its necessary superiority in the early diagnosis of tuberculosis of the lungs.

Unfortunately phthisio-therapists disagree on what constitutes an early diagnosis. Weicker is quoted in the Journal of Tuberculosis to the effect that "The early diagnosis implies the recognition of closed foci in the lungs, which furnish no bacilli bearing sputum." In the same journal Fraenkel says that "No diagnosis of any localization of tuberculosis is complete without the demonstration of the bacillus."

Nor do they agree much better on the means of making an early diagnosis.

Thus Brooks maintains that the "Tuberculin reaction is too promiscuously present in other diseases, uncertain, unacceptable and not entirely without danger," and that "It has been repeatedly shown that the glycerin and proteids of the culture are in themselves sufficient to produce the reaction (Journal of Tuberculosis, Vol. iv., No. 3)."

Tyndal relies upon the ear in auscultation for settling the diagnosis, and Brooks thinks that the thermometer is after all the best instrument in the diagnosis of early phthisis. (Journal of Tub. Ibid).

Weicker, Knopf, Tyndal, Brooks, Von Ruch and others may support Hildebrand in insisting that "Thus far the Rœntgen rays have added nothing in certainty to the older methods;" but their own disagreement on what constitutes a certain early diagnosis as well as on the value of each other's methods deprives their opposition to the new method of meaning.

The objection that when a shadow is found the disease can no longer be considered in its incipiency is valid. But the Rœntgenologist does not claim to diagnose tuberculosis of the lungs at its absolute incipiency; nor does any other method enable us as yet to do so.

It is by making the diagnosis of the prebacillary stage of tuberculosis of the lungs more certain that the new method adds to its earliness, whereas by aiming too much at earliness of diagnosis we may add to our record of percentage of cures (Goetsch cured 71 per cent., Trudeau 83 per cent., Journal of Tub., Vol. iv., No. 2), instead of rendering the diagnosis more certain.

It is easier to pile up a record on metamedical personal aptitude than on impersonal skiagraphs.

II. *Technique.*

1. Short exposure serves to eliminate to an appreciable extent the fogging due to vagrant rays.

2. By making the exposure while the expanded chest is entirely at rest we avoid the blurring of lung detail produced by the movements of respiration. Time exposure, on the other hand, necessitating respiration, defeats the very purpose

Tuberculosis of Lungs. Time of exposure, one second, without intensifying screen.

of skiagraphy, the bringing out of detail the screen fails to show. To insist, therefore, on absolute inmobility in the case of a hip and to utterly neglect this in case of a chest is strikingly inconsistent. Yet that has been the common practice in this country until quite recently. Thus an American manufacturer boasted only a year ago that his coils would take a chest in 30—40 seconds, which, he says, is 50 per cent. quicker than any others of which he "Has any knowledge."

Yet it is a fact that Mr. Isenthal exhibited instantaneous chests in London as much as three years ago (Archives of the Rœntgen Ray, Vol. v., No. 3).

At the previous meeting of this society last December, Dr. M. K. Kassabian of this city urged the advantage of short exposures and showed a good chest taken in 30 seconds on the installment plan. Upon the same occasion I exhibited my one second and one-half second chests, with and without intensifying screens.

Von Ziemssen and Rieder published in their beautiful atlas, "Die Rœntgographie in der inneren Medicine," the results of one second or shorter exposures in 1901; their first results of instantaneous skiagraphy having been published in 1899.

I adopted the method fourteen months ago. Since then all of my chest work has been done in one second or less.

I use for the purpose an 18-inch Queen coil with a variable inductive resistance and a Wehnelt interrupter energized by the 110 volt direct Edison current.

My plates are ordinary X-ray plates of various manufacture, and I do the developing myself. The tube must be just right, and is first carefully tested, not by a parallel spark gap which is worse than useless, nor by using the hand for a test object, but by means of a Walter skiameter. For a medium sized and very large chest I use a Gundelach Wehnelt tube that will just show six holes in a Walter skiameter. For a small chest a Walter 5 tube is better.

For the sake of obtaining much contrast one or two tungstate of calcium intensifying screens may be used. The use of screens results, however, in the sacrifice of some detail.

SUMMARY AND CONCLUSION.

Skiagraphy of the chest is significant not merely as corroborating the results obtained by the older methods, but as a valuable supplementary method of physical diagnosis.

For the analysis of the phenomena of motion skiagraphy is less applicable than diascopy; but for obtaining pathological detail it is far superior and possesses the advantages of the graphic method.

The object to be skiagraphed should be as nearly at rest as possible; this is as true of the lung as it is of the hip. Momentary exposure (½-1 second) during suspended respiration is long enough. Flash exposure is possible, and we shall come to it in the future.

To skiagraph limited portions of the chest diaphragms should always be used. For this purpose I use my X-ray camera, a modification of Albers-Schönberg's compressionsblende.

To secure more contrast, though at the expense of some detail, the dry plate or film may be sandwiched between really fine-grained calcium tungstate.

A good induction coil is at present the only available instrument capable of furnishing the requisite electrical energy.

The tube must be able to keep its vacuum. A critical tube for a medium-size chest should give a skiametric reading of W. 6 or its equivalent.

The lowest tube that will do the work is the best for the purpose.

INSTANTANEOUS SKIAGRAPHY OF THE THORACIC ORGANS.

MIHRAN K. KASSABIAN, M.D.,
Of Philadelphia, Pa.

Director of the Roentgen Ray Laboratory of the Philadelphia Hospital, Etc.

We are acquainted with the fact that it is by no means an easy matter to produce perfect skiagrams of the thoracic vicera. Especially has this difficulty shown itself in former years, when in order to produce a skiagram, it was necessary to prolong the exposure, resulting in a more or less defective skiagram, entirely due to the cardiac and respiratory movements. With the production of improved X-ray apparatus we are now in a position where the time of exposure has been lessened from one to four minutes, to as many seconds, and even less, with a distinct improvement in the resulting picture.

The production of such skiagrams, independently of the cardiac and respiratory movements, depends directly upon two things: First, upon the employment of an outfit that is as perfect in its construction as possible, and secondly, upon a technique that has proven to be entirely correct. Therefore, to overcome the defect in skiagrams, due to movements during respiration, it is necessary to expose the part and plate to the action of the X-ray momentarily, and this at the end of the inspiration period. In the case of the heart the exposure must obviously be instantaneous, or at least synchronous with the whole or a part of the cardiac cycle.

I shall now consider the apparatus which I employ, and which I have found especially useful to determine the outline and condition of the organs in the thoracic cavity.

(a) Runmkorff Coil:—This is the most important part of an X-ray equipment, and without it our endeavors, so far as thoracic work is concerned, would only be rewarded with fruitless

results. Some authorities claim that a static machine will do as good work as the coil, but I cannot agree with them, as the results of careful experiments made with both apparatus disprove them. The coil to be employed for the very best skiagrams should be of twenty-inch spark producing capacity.

(b) The next part of the apparatus and without which a coil would be useless, is the interrupter. Of these there are a large number of different patterns on the market. During the past seven years I have tried nearly all of them, arriving at the conclusion that the electrolytic alone gives satisfactory results in rapid thoracic skiagraphy. As the electrolytic interrupter causes a rapid "make" and "break" (from 8,000 to 16,000 interruptions per minute) it exactly satisfies the needs of the coil for skiagraphing the heart and lungs. If the interruptions per second are known by increasing the number the "make" is lengthened in time and frequency and the result is an increased discharge from the secondary coil. The excitation of the tube and penetrability of the rays depend upon the "make" and the number of vibrations of the interrupter, if they be increased the efficiency of a tube and the emanating ray will likewise be improved. From the above it may be inferred that a mechanical interrupter would be unsuitable. The number of interruptions (from 650 to 900 per minute) being by far too few in number to employ with any degree of satisfaction in rapid thoracic skiagraphy. Furthermore the amperage in the electrolytic is greater than that in the mechanical.

(c) Crooke's Tube. For rapid exposure work a tube with a very high degree of vacuum should be used. This means that the power of penetration is also high, a fact which has been proven very essential in rapid skiagraphy of the thoracic organs. The degree of penetrability is best measured by means of the fluorescent screen-hand method.

(d) Intensifying Screen. Many authorities highly recommend the employment of intensifying screens to accelerate the action of the rays upon the exposed plate. I have employed the screens very largely, and have come to the conclusion that they should be used only in those cases where the patient's safety demands the shortest possible exposure.

Normal Chest.

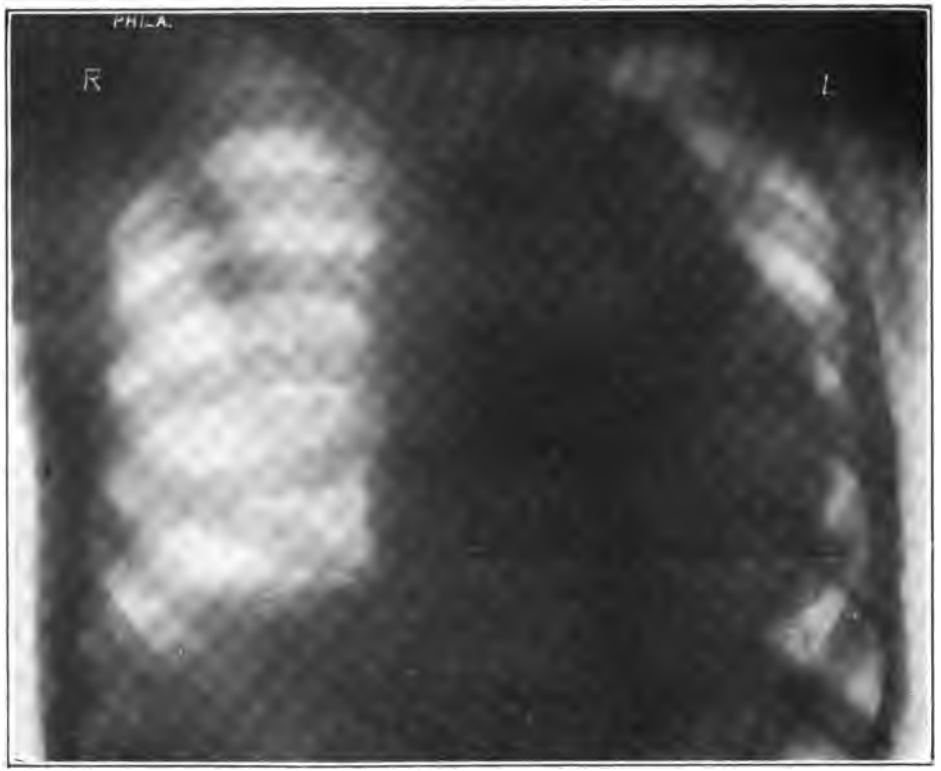
Of the various procedures for accelerating and intensifying the action of the rays upon a sensitive plate, only one has thus far proven to be of any use in my hands, i. e., the approximation of a fluorescent material upon a sensitive plate is very much like ordinary light, in other words, the rays are enhanced in their effect by the fluorescence. In employing intensifying substances, it becomes necessary to bear in mind two factors, namely, the granularity of the fluorescing surface, which greatly reduces the definition of the resulting skiagram, and almost effaces the details of the smaller osseous structures, and the necessity of either using color-sensative (ortho-chromatic) plates, or first color sensitizing ordinary plates, since the best screen (platino-cyanide of barium) fluoresces with a yellowish green light which does not greatly affect ordinary dry plates.

The resulting skiagrams present most excellent results. The advantages of the tungstate of calcium screen are the sensitive dry plate does not have to be first color-sensitized and the cost is very much below platino-cyanide screens.

(e) Sensitive plate. Screens in skiagraphing the thoracic organs to a great extent depend also upon the type of variety of sensitive plate employed by the skiagrapher. The sensitiveness or degree of rapidity with which a sensitized plate is affected by the X-rays bears a close relation to the light sensitiveness under ordinary circumstances. In experiments which I performed several years ago I observed the radiographic and photographic sensitiveness to be about equal up to 80 or 100 measured according to the scale of Driffield. Furthermore, in these experimental investigations I proved that a higher degree of sensitiveness to light had no corresponding parallelism so far as the sensitiveness to the Rœntgen ray was concerned. In skiagraphing the thoracic organs it is essential to use a plate that is "extra rapid" as is manufactured by nearly all of the up-to-date plate makers. The plates which I used in the following experiments were doubly coated with the emulsion but only on one surface, this plate being better by far than the one ordinarily used in photography, or films.

The technique of skiagraphy of the thorax is as important as the style of apparatus used, and this I shall next briefly consider. Without a proper technique the results of thoracic skiagraphy are practically fruitless.

(a) Position of patient. The patient may be placed in either the recumbent, semi-recumbent, sitting or standing position. In order to bring the shadow of the lungs, heart and aorta clearly, the patient should be placed in the ventral-recumbent posture, with arms folded above and over the head. This posture serves to bring the above organs nearer to the plate, hence more distinct shadows are obtained there when the patient is placed in the dorsal-recumbent posture. In the former position, the shadows produced by the scapulæ and vertebræ do not interfere with the shadows cast by the organs. The shadows in the illustrating skiagrams are narrowed down and placed along the edge on each side of the thoracic cavity. In shortened exposures the shadows of the vertebræ are practically obliterated or at least greatly diffused. It goes without saying that the plate is placed under the patient with X-ray penetrating the thorax from above. I employ the dorsal-recumbent position when there is a consolidated area in the posterior portion of the lung, as may be first determined by means of the fluoroscope. This would serve to bring the diseased area nearer the sensitive plate than is the case if the patient were placed in the ventral-recumbent posture. Another instance where I employ the dorsal-recumbent posture is in aneurysm of the aorta (of large size) and especially when there is associated extreme pain which would prohibit the placing of the patient in the reverse position. In this case the tube should be placed under the table, the rays penetrating the thorax from its posterior aspect, with the plate placed above and in touch with the anterior chest wall. Care should be exercised to fasten the plate in such a manner as to prevent accident from moving the patient as may be the case with those afflicted with nervous disorders. Some authorities recommend the standing or sitting position,—these I have never been able to successfully employ, because the major number of cases under X-ray examination are nervous and when a spark



Coil 15 in., 110 volts direct, mechanical interrupter; patient, 150 lbs., prone position. Diagnosis-Aneurysm of Oarta and dilatation of heart, outline of heart is sharp, due to the less muscular action. Time of exposure, 20 seconds, without intensifying screen.

or slight noise is produced they will move causing an unsatisfactory result.

The exposure of the part to the action of the rays, in order to produce a satisfactory skiagram of the thoracic organs, should be made with the lungs filled with air—the patient having been previously instructed to hold his breath.

A number of experiments were conducted at the Philadelphia Hospital, with assistance of Dr. F. C. Johnson. The technique employed is explained in the subjoined cases.

Case 1. A young adult 5 feet, 5 inches in height, weighing 140 pounds, normal lungs and heart; all clothing was removed, patient lying prone with arms folded over head. A special photographic plate 14 by 17 inches in size and an intensifying screen (11 by 14) were placed under the thorax. A 15 inch Ruhmkorff coil, with an electrolytic interrupter was used. Current 110 volts direct. Crooks tube was placed directly over the dorsal vertebræ the anode forming an angle of about 20 degrees with the plate. The tube was distant from the plate about 22 inches; the amount of voltage to the primary coil during exposure could not be registered exactly (25-40 volts) due to the sudden switching on and off of the indicator; amperage about 20-25. The exposure was made while the patient had lungs deeply inflated by air during inspiration. The time of exposure varied between 1½ to 2½ seconds. Developed in Metol Hydroch. developer, came up slowly, continued this process about 25 to 30 minutes, negative has not been intensified in bichloride solution.

The Skiagram. No. 1. The skiagram exhibits, considering that the time of exposure was very short, a great deal of contrast, bones not showing well, on account of being underexposed. The lung, due to the contained air, appears to be emphysematous.

The blurred effect of the ribs is due to a sudden jumping of the patient during the switching off and on of the current. The difference in the shadows may be observed where the intensifying screen was used.

This position is best for skiagraphing the heart, the organ being thereby brought near to the plate, a matter highly essential. The size of the heart as seen on the skiagram is 16

cm. as measured from apex to base. The position is apparently normal. The borders of heart are not sharp being blurred more or less, a condition undoubtedly produced by the intensifying screen.

The longitudinal shadows, three-fourths of an inch in the short axis and six inches in the long axis on both sides of the upper thorax are produced by the respective scapulæ. It may be observed that these shadows do not interfere with those of the ribs and lungs.

The normal position of the diaphragm on the right side is slightly higher than on the left, and there was no movement of it as is normal during respiration. The upper margins, therefore, are clear cut and sharply defined.

DISCUSSION.

Dr. Gordon G. Burdick, Chicago: The subject has been covered thoroughly by both of the essayists and they are deserving of a great deal of credit for the results they have achieved. We in Chicago have done some of this instantaneous skiagraphy and have had a certain degree of success along that line, but as a general proposition we have found that our results are better from prolonged exposure than from an instantaneous exposure. An exposure of from fifteen to thirty seconds is an instantaneous exposure, except so far as the heart is concerned. It seems to me that the tendency at the present time is to make longer exposures. The great percentage of loss in tubes was, perhaps, instrumental in bringing about this change. I know that in my own practice I lost three very valuable tubes in succession in a very short time in attempting to make instantaneous exposures, and as these tubes all cost twenty dollars apiece I found the work to be rather expensive. The question of expense alone will not serve to make this work popular.

Much of the success in instantaneous skiagraphy is due not so much to the X-light as to the developer that is used. There are several developers that will do this work. To me it is very astonishing that Dr. Hulst has succeeded in making hydrochinon do his work. I have not been able to achieve his

results with hydrochinon, nor do I know of anyone else having been able to do so. Hydrochinon is the most peculiar developer I know. It is very slow in action; rarely will an exposure even to sunlight appear before a minute or two after immersion of the plate in the developing solution. It makes very little difference whether you use the carbonate or the bromide, you can continue to use the developer for hours without its showing any disposition to fog. As a general rule you will find that you will get few half tones with a developer of that character. It intensifies the high lights at the expense of the middle tones and your picture will have only shadows and high lights without any of the desirable middle tones.

Amidol, rodinal and metol, when used carefully, are capable of fulfilling the conditions Dr. Hulst mentioned and showed. They require less than one-fiftieth of the exposure, amidol in particular, of any other developer we have. One difficulty with amidol is that when we want to make positive prints we must first intensify the negative in order to impart a little color because the deposit of amidol is rather inclined to blues and does not make a very nonactinic color for printing purposes. None of the yellows or browns or grays are formed in it. The negative always looks nice, but before printing from it we must intensify it so as to impart a little yellow to it. It is only another chance of spoiling the negative before it is completed.

Rodinol, on the contrary, gives us a very nice negative and also a good positive, but it is a liquid developer. For some reason it is not used as much as it deserves. For instantaneous work I fear that you must follow along the lines I indicated. Hydrochinon has astonishing qualities, and it is possible that by putting it into a proper combination you may overcome its objectional features and make it do what otherwise it would not do. It is the most contrasty, most contrary and the slowest developer we have in photography, and if any one has discovered a way of making it do this instantaneous work I would be under great obligations to learn how it is done.

DR. KENNON DUNHAM, Cincinnati, O.: I would like to ask the essayists to bring out in their closing discussions one very important matter. Dr. Hulst stated that the best tube for making these instantaneous skiagraphs is a low tube; whereas, Dr. Kassabian stated that he believes that the high tube is the best. I would like to know just what these gentlemen mean by a high tube and a low tube. The point being that a high tube is made higher or made more efficient by spark gaps and other resistance. Does Dr. Kassabian refer to that as a high tube?

Is Dr. Hulst meaning the same, when he speaks of a low tube?

DR. PRESTON M. HICKEY, Detroit, Mich.: My interest in X-ray work was aroused by the value which I thought I might receive from it in the diagnosis of chest diseases. But I noticed that neither of the authors paid any attention to the value of certain of the shadows that are seen in these instantaneous skiagraphs. It seems to me that we do not yet appreciate the full value of these pictures; that is, we do not yet know how to interpret many of the shadows we see in a rapid exposure of the chest. Take, for instance, these branching shadows down along the spinal column, in fact, all over the chest; it is a question in my mind whether we have there a shadow of the blood vessels, or whether these are the shadows of the bronchial tubes.

To determine this I made some experiments. I injected a cadaver and made a number of exposures. I compared the shadows I obtained there with the shadows obtained in different exposures of the chests of patients and found that they corresponded exactly in size and in direction. I then took a number of lungs from cadavers and filled the bronchi with fine shot and the blood vessels with a thick lead solution. By filling the bronchi with shot I was able to differentiate them from the blood vessels because of the interruptions in the shadow. I found that the lines of the bronchi and the line of the blood vessels followed each other pretty closely.

It is a matter of very great importance to be able to interpret these shadows in skiagraphs of the living chest. The

question naturally arises,—Are these consolidations of the lung tissue? At first I was tempted to consider them as such, but I am no longer of that opinion since I made my experiments as I have indicated. We must compare both sides of the chest very carefully before we make a diagnosis of our findings. Furthermore we must remember that the shadow of the heart will cover up one side and thus break the line of the blood vessels. A corresponding allowance should be made on the other side.

MR. H. SNOWDON WARD, London, England: I wish to thank the officers and members of this society very sincerely for the courtesy extended to a stranger. These two papers are extremely interesting. They bring up one point which appeals especially to me, perhaps because I am a photographer, and in this connection I wish to make a suggestion to those who are dealing with rapid exposures.

Some five or six years ago some experimental work was done in the direction of comparing the sensitiveness of dry plates to the X-ray with the sensitiveness of the same kind of plates to light. Generally speaking, the conclusions were that up to about 100 H. & D. the sensitiveness of the plates to the X-ray under all conditions very closely followed the sensitiveness of the same plates to daylight. But when we got beyond 120 H. & D. from that up to 150, (the greatest daylight sensitiveness we could obtain at that time), we found that there was a very rapid falling off in sensitiveness of the plates to daylight. The plates extremely sensitive to light gave less contrast in the developed negative under extreme exposures to the X-ray than did the plates which were relatively less sensitive to daylight.

I would like to suggest that these gentlemen making rapid exposures should give us, as often as possible, the daylight sensitiveness by some method of distinction in order that we may get a series of data which will, to a certain extent, enable us to compare the daylight sensitiveness with the X-ray sensitiveness. With a given emulsion, if you double its thickness you practically double its efficiency for radiographic work. It is a pity that actual quantitative work cannot be carried for-

ward on these lines. It would require the cöoperation of the emulsion maker and the expert radiographer.

DR. HULST (closing the discussion on his part): I am interested in the developer I am using. I formulated it several years ago, and although I have tried other developers from time to time, yet I have always come back to my own. I find that I can do better work with the hydrochinon developer than with any other. I am very careful about the temperature of the developer. It should not be used too cold because then it is very slow. I have no trouble with it when I use it right. I would like to suggest to Dr. Burdick that one reason why he has trouble with it is that he probably uses old solutions. I never use my solution twice. That is expensive, but I prefer to throw the developer away or use it for less particular work than to use it twice on this instantaneous work. I must say in explanation, however, that I always develop two plates.

The Germans have used glycin. I have used it for other purposes but find it less satisfactory. I have also used rodinal and edinol with acetone sulphite, which works very nicely. But after all I do not think that so much depends upon the developer. Any good developer with any ordinary plate will do. I have used them all and I am convinced that it is not that. It is the way they are used. It is whether the plate has been affected sufficiently by the X-ray and whether you use the developer properly. Of course, it is important not to have the tube too high or too low and to have enough current.

I have found hydrochinon contrasty but not contrary. It is my best friend.

The main reason for rapid or instantaneous work is to place it in the same category as other work. To do that we know that the object skiagraphed should be at rest. We strap people down on the table in order to have them quiet. It is a wonder that we can get any good pictures at all of the lungs in motion. The only way to take a good picture of the soft tissue as of the lungs is to have them at rest, and to do that we must do quick work. You cannot do that with the static machine; it does not furnish enough energy for this purpose. It is better to take five seconds and make sure that we will have a good plate. We must have adequate apparatus and

then we can do the work as quickly as we like, something depending, of course, on the sensitiveness of the dry plate. I believe that the time will come when we will skiagraph the heart beat in all its phases; make a sterioscopic picture of it. There is no reason why we should not get a clear picture of it, because we get that as it is now.

As to the tubes used: Any tube that will stand the current, and possesses good definition, is a good tube and will do the work. I have come to use the Gundelach tube almost entirely. It is the cheapest tube for me to use, but I never use a twenty dollar tube. I use more expensive tubes, and I have broken one hundred dollars worth in one day; but that was long ago and I have gotten over that. You must test your tube first, not with the highest current but with the lowest current. And when everything is just right go ahead.

Talking about one-half and one second exposures, I wish I could clearly and exactly determine exposure time of fractions of a second.

To talk about a high tube and a low tube and a soft tube is like saying a long time and a short time. It really means nothing. We must have a skiameter to tell us what we are doing. With a tube that will penetrate a Walter skiameter six an 18 inch coil is needed for one second chest pictures. But I think that we should have coils that are more powerful. If I had enough of this work to do I would get a forty-six inch coil and see what could be done with it. I have a picture on exhibit which is supposed to show an aneurysm of the abdominal aorta. There is only one picture like that work. It is in Germany and was made with a one hundred cm. spark coil. I showed my skiagraph to Dr. Crane and he agreed it is an aneurysm of the abdominal aorta. An eighteen inch coil was used.

With an inductorium capable of furnishing practically an unlimited amount of energy, it is possible to use a greater range in tubes. Higher tubes can be used to get results for which lower ones are needed with inferior inductoria. The whole business of skiagraphy is a matter of balancing conditions. What you alter in the tube you balance in the coil. What you alter in the coil you must balance in the tube. It is a

knack that is a little difficult at first, but when once you get it it is not so hard, and you will surely get a good picture unless you break the plate.

DR. KASSABIAN (in closing the discussion): The ordinary photographic plate does not give as good results in skiagraphing as the specially prepared plates for this work. Several years ago, I experimented by raying my hand on an ordinary photographic plate and again on a second but specially prepared plate. I exposed both of the plates for the same length of time, and when I examined them I at once observed a marked difference in the shadows of the two plates. Of course, they will answer very well for skiagrams of the hand but they will not be suitable for thoracic, abdominal, or hip cases. If you are skeptical about this, repeat the experiment and convince yourselves.

About the degree of vacuum of the tube:—This is a much disputed question, and in this connection let me say that if the operator is thoroughly familiar with his apparatus, if he knows the voltage and amperage of current in his primary coil, the distance at which his tube should be placed from the part, the spark lengths of the secondary coil, etc., his work will usually be entirely satisfactory. I do not recommend testing the tube with the fluoroscope. It is very injurious to the hand and this is the reason why so many of us are suffering with dermatitis. For thoracic, belly and hip cases the vacuum of the tube should be very high, in fact as high as is possible to get. For other parts of the body a lower degree of vacuum will suffice. The higher the degree of vacuum the more will be the penetrative power of the rays and the less the absorption by the tissues—hence a lessened time of exposure. In order to make it more useful to the profession at large we should keep accurate records of everything we do. Every skiagrapher should have a big record book or sheets that can be bound or filed away, and every time he makes a skiagram he should put down the full history of the case, the technique he uses, the apparatus used and everything that would be of value to others. We cannot memorize all this. I originally recommended using a little book in which I noted the voltage and amperage, the length of exposure, position of

patient, whether it was a success or a failure, etc. If we say, "I have exposed for so many minutes" without giving all the other details, our information will not be of much service to any one else, as it is incomplete. The only satisfactory way consists in keeping a complete record and whenever we report a case in societies or in journals the complete history and all those other data that I have mentioned should be enumerated. In that way we obtain the full benefit of other operators' experiences.

Instantaneous skiagraphy is not at the present time as successful as we expect it will be in a short time and I hope that the time will soon come when every one will be able to take the excursions of the diaphragm, the lungs, the heart, etc., in a few seconds, or in even the half of a second. This is an important and direct step to the methods of taking skiagrams in rapid succession, of such organs above mentioned, and their reproduction in kinetoscope fashion. I have devised an apparatus whereby this will be possible, and as soon as the method is fully complete I shall demonstrate it to our members.

THE CARE OF STATIC MACHINES.

BY H. E. WAITE, M.D.,
Instructor and Demonstrator of Electrical Apparatus at the New York Post Graduate Medical School and Hospital of New York City.

At present there are three types of influence or static machines used in medicine, viz.: the Holtz, Toepler-Holtz and Wimshurst, the first two mentioned being more generally used. The Wimshurst has been on the market several times, but not having met expectations, has proved a failure, owing to its construction and its lack of uniformity in generating current.

The following remarks concerning the care of static machines will be found applicable to either type, as the principles involved in both are essentially the same.

A general misunderstanding prevails concerning the cause of the trouble which will at times occur with even the best static machines. The difficulty is variously ascribed to rainy weather, dampness and kindred causes, where as the fact remains that the arch enemy of the static machine is vapor, and to this cause almost entirely may be attributed the failure of a machine in otherwise good condition to accomplish (during the muggy weather of July and August) that which is expected of it.

With this in mind, the owner of a static machine will at once realize how essential it is to keep his machine free from vapor by judicious cleaning and by having the case air-tight; or, if the disturbing element has already gained entrance, to take such steps as will speedily rid the machine of the causative factor in the trouble.

If, from any cause, vapor has accumulated inside the case, I would suggest, in order to remedy the matter, that two or three fruit jars be filled with cracked ice and rock salt (one part of rock salt to two of ice), the covers screwed down tightly and the jars placed on saucers in the case of the machine, the doors of which should then be closed. At the expiration of about fifteen minutes

frost will be found about half way up the jars and some water in the saucers. The jars and saucers should then be taken out, wiped dry and replaced, the operation being repeated three or four times, or, if the machine as well as the day be very damp, it may be necessary to repeat the procedure five or six times, always being careful to close the doors. The jars having been finally removed from the case, chloride of calcium should now be placed therein and the doors closed at once, when, in a short time, the machine will charge without any further difficulty. Should it for any reason be deemed necessary to open the door, it will be found that running the machine during this period will, to a certain extent, prevent the condensation of vapor upon the plates.

Right here it might be well to mention the various materials that have been placed inside the case of static machines to serve as dryers. These are sulphuric acid, sulphuric acid and pumice stone, powdered chloride of calcium and quicklime in lumps unslaked. While all of these have been used and a number more, my preference is for well baked chloride of calcium on account of its quick action. This should be baked in an open dish over a red-hot stove until bubbling ceases and no evidence of moisture is apparent. It should be used only when cool. I have also found quicklime in lumps quite effective, but as soon as it crumbles into fine dust it should be removed, as the dust will rise and settle on the parts of the machine, and while no harm is done it does not add to the machine's general appearance. The lumps can be placed in jardinieres or wooden boxes made to fit the available space and covered with close mesh fly netting to prevent the escape of the dust.

An important point in the care of the static machine, and one I cannot too strongly impress upon your minds, is the necessity of keeping the machine absolutely clean. Not only should the front of the case be carefully looked after, but the prime conductors, rubber insulation, brass balls and everything about the machine should be rubbed clean and bright every day, eternal vigilance as to cleanliness being requisite to ensure a perfectly working machine. For this purpose no extensive paraphernalia is required—merely a piece of cheese-cloth with a little vaseline rubbed in (not enough to be sticky), and with this the prime conductors and other parts can be kept clean and shining.

As to the plates of both machine and charger they may be cleaned with kerosene oil and then rubbed dry with cheese-cloth and vaseline. This may be required once or twice a year.

The brushes of the Toepler-Holtz machine need frequent looking after. They may be easily cleaned by rinsing them in a solution of caustic potash, then washing in hot water and allowing them to dry. This will remove such dirt and oxide as may have adhered to them and the brushes will then be as good as new. Kerosene will also clean the buttons or sectors.

It is also important to keep the glass legs of the insulated platform clean. The tendency of the machine when working is to attract particles of dust from the atmosphere, and has doubtless been noticed by many of you; this, taken in connection with the vapor that is deposited on the pole pieces and the legs of the platform, may (when the platform is connected with one of the prime conductors, the other being grounded), short circuit the machine.

The following will doubtless be recognized as a familiar proceeding on the part of the physician owning a static machine when for any reason it suddenly ceases to work. The first thing the perplexed and irate doctor does is to open the door of the case and attempt to start things moving by brisk rubbing with towels, catskin or anything else that may be at hand. Unfortunately his zealous efforts in this direction will meet with failure, and, after a few minutes, puzzled, perspiring and vowing dire vengeance, he will be inwardly saying condemnatory things about the weather and audibly making terse and emphatic remarks (far other than complimentary) about the manufacturer of that machine in particular and the cussedness of static machines in general. Next is an impatient telephone message to the office of the manufacturer about the failure of the machine to "charge."

The reason for the non-success of the method just described may be explained as follows: The calcium or other dryer contained in the case had lowered the temperature inside below that of the outside atmosphere; as soon as the door of the case was opened, the vapor of the outside air immediately condensed upon the plates and the machine could not then be worked until it was thoroughly dried out. This condition of lowered temperature inside the case is also instrumental in bringing about a condensa-

tion of vapor upon the outside of the case, thus causing the current to be short-circuited and the machine to be discharged. The importance, therefore, of keeping the machine dry and clean is at once apparent.

The shortness of the spark and the quick spitting easily reveals the fact that there is vapor in the case, the discharge being uneven, and the best method of remedying the difficulty is, as described above, by means of the jars containing cracked ice and salt.

When everything is dry inside the case the machine will work even though the humidity outside be 80, 90 or even 100°. The force, however, will, of necessity be less, owing to the fact that the current is conducted off by the vapor.

Sometimes it becomes necessary to dry out the inside of a static machine, as when the plates become sticky and a gluey substance forms on the inside of the case and upon the insulators. Just what the nature of this substance is, I have not been able to determine, but I have noticed it frequently when I have used chloride of calcium without rebaking it. In order to dry out the case a Bunsen burner may be used. The flame having been lighted and the burner properly adjusted, it should be placed within the case, the door of which should be fastened at the top, but sufficient space should be allowed at the bottom to provide for the admission of air into the case, otherwise the light will go out. The circles should now be kept revolving slowly, as this keeps the air in circulation, and when everything gets hot inside (the straight plates, round plates and the case itself) both doors should be opened and the machine allowed to run until it is cool; the doors should then be closed and the process repeated. Should a Bunsen burner not be available, a good-sized kerosene lamp may be used, but *care must be taken that it does not smoke,* as the carbon from the smoke will settle on the parts of the machine, forming a good conductor. By watching the lamp any trouble of this kind may be avoided.

A case came under my observation in St. Paul where a machine had been shipped by way of the lakes and become soaked with water. The revolving plates were opaque white and while the machine could be charged, only a spark of two or three inches long could be obtained. I was nonplussed for a time as to the

cause of the trouble and how to remedy it. I took a large Bunsen burner, placed it in the case as previously described and allowed the machine to revolve. Very soon I noticed the disappearance of the opaque white in patches. I kept the machine in motion, alternately opening and closing the door, for about half or three-quarters of an hour, after which I put in chloride of calcium and closed the door. After this treatment the machine gave a spark seventeen inches long. The trouble was no doubt the absorption of water in the lacquer on the revolving plates.

In all seasons of the year when the atmosphere is cool and comparatively free from humidity, it is at times advisable to take out both doors of the case and allow the circles to revolve slowly for half an hour or so—cold, fresh air circulating about the plates goes a good ways towards keeping a static machine in working order.

I feel confident that if those members of our profession who own static machines would be careful to see that their machines were cleaned properly and often, they would get more satisfactory results and save themselves much unnecessary trouble and annoyance.

No. 217 East 23rd Street, New York City.

DISCUSSION.

DR. W. W. JOHNSON, Rochester, N. Y.: For two reasons I have considerable diffidence to attempt a discussion of this very interesting paper. The first reason is that Dr. Waite has been making static machines longer than anyone here and he knows more about them than any of us. The second reason is that so many of my friends here have told that they do not care about the static machine; that they never use it. But I, too, have made static machines, and I take care of them, and I like them; therefore, I am always ready to stand up in defence of a friend.

Dr. Waite spoke of three kinds of influence machines. He says that the Wimshurst machine has been on the market several times; that it has been thrown out repeatedly because it does not "fill the bill." He also said that it did not generate well.

I cannot agree with him. My experience with this machine leads me to say that I consider it the most faithful of any of them,

but on account of the mechanical problems involved the Wimshurst machine is out of the question. It cannot be constructed with any number of plates without having a counter shaft and a multiplicity of belts introducing problems that make the work somewhat difficult. The eight-plate Wimshurst machine I built worked every day in the year and without rebaking the calcium chloride, which I put in but once a year. I have also built two Toeppler-Holtz machines, and both of them work every day in the year, and faithfully too.

Of course, I look after my machines so that I can get maximum efficiency out of them. The dryer I use is calcium chloride. I have tried all the methods, even Dr. Waite's, but I can dry out my static machine while he is getting his charges ready. I do this with calcium chloride, but I bake it myself and, perhaps, in a peculiar way. I take an old-fashioned plain drip pan, put the calcium chloride into it and put the pan on top of the range, which is quite hot. The calcium chloride is melted easily and it soon begins to boil. As the moisture boils out take a spatula and stir the mixture. At the bottom of the pan you will find the calcium chloride collecting in a solid layer. It is being fused. You can go on and boil out the water, not touching the mass at all, and in that way you will have a calcium chloride that has been fused, but it is not as good as what I get with my method. With the spatula I continually stir the mass until after a while it has the appearance of maple sugar. Then at the last it will puff up and you have a porous mass of calcium chloride that will absorb the water in a static machine better and faster than anything else. I keep enough on hand to charge my machine twice. I keep half in the machine and half in a sealed can. When the calcium chloride in the machine is saturated with moisture I take it out and put in the other portion that I have kept in the sealed can. So that I always have my machine perfectly dry. I can bake a new batch at my leisure. I can dry out my machine in from fifteen minutes to half an hour and get the maximum spark gap. With a little watching and care I am able to keep my machine in good working order all the time.

I never notice my calcium chloride wetting down so that it looks like a sticky mass. When I first put it in it is porous and hard. After a while as it takes up moisture I notice cracks on the

surface and then it "feathers" out. When it has "feathered" out to a certain degree I know that it is time for me to put in a fresh charge.

Whenever my machine changes polarity during the day I know that it contains moisture, and that night I put in a fresh charge of calcium chloride so that I will not have any trouble the next day. Sometimes if the machine is slow in picking up its charge, or if it refuses altogether to pick up its charge, I have an outside charger, and that is a Wimshurst machine which works every day in the year. I charge it by inserting a wire. I have a hole with a cork in it. I take out the cork, put in the wire, attach it to the brushes, work my Wimshurst machine, put one side next to the wire and it immediately starts.

One way to keep the machine clean on the outside would be for the manufacturers to plate the brass parts instead of lacquering them. It would be more satisfactory.

In regard to the use of the static machine for X-ray work, there is no doubt of its inability to do rapid radiographic work. When I say rapid I speak in comparison with the radiographic work done today by the coils. No man need feel that he can do rapid radiographic work with the static machine as compared with the coil, but for fluoroscopic work it is all right and can demonstrate every part of the skeleton just as well as the coil. When it comes to treatment, the static machine is just as good in every respect as the coil. I think that anyone with the proper static machine and the proper tube, which is the important thing, can do the work. The static machine needs a very much lighter tube and a smaller tube than does the coil.

The personal element enters into this work to a much greater degree than is supposed. One man uses one apparatus or method, and the other man uses another, yet they both get the same results. The tube I use is a Monell tube. It is a plain tube and not a reducing tube. I used the same tube every day for three years. When it got so high that I punctured it, I had to have it repaired. Very soon afterward it again got so high that I was afraid of it. So I baked it and then it worked very nicely. And now I bake my tube every day. It takes me from ten to fifteen minutes, depending on the heat in the range. I bake that tube so much that when I hitch it up to the static machine without any

spark gap there are no X-rays generated at all. You can see the violent cathode stream come across to the anode and on the anode I have noticed a little bubble or two, of a blue and yellow or a golden and red color. They disappear immediately when you bring out the spark gap.

In the morning I have my tube in that shape, and when I am ready to use it I use a series spark gap, using on the negative side a spark gap of—well, there are a dozen buttons one-fourth of an inch apart, and I pull it out full extent. During the afternoon I will have it back again so that there is nearly no spark gap at all. Once in a while there is a day when I have a great deal of work to do so that I may have to bake my tube twice. Or I bake it again if I want a particularly soft tube. In this way I get along very nicely, and although, like all other operators, I have some failures, yet the bulk of my work is extremely satisfactory.

Dr. John T. Pitkin, Buffalo, N. Y.: I was greatly interested in this paper because I am very strongly attached to the static machine. There is, as you know, a great amount of moisture in the atmosphere during the months of July and August. This moisture interferes with the taking and retaining of the charge of the apparatus. Before I thoroughly understood the management of the static machine I had considerable trouble during these months. The manner in which I now overcome the moisture trouble is by the employment of about half a bushel of quick lime; this I place in a separate chamber which I have built under the instrument proper, but having communication therewith. The chamber is constructed so that it can be opened to replenish the dryer without opening the main portion of the case; thus the taking down of one entire side of the instrument is rendered unnecessary. A wooden box that retains the lime in the separate chamber is perforated by many small holes to admit of the free circulation of air, but preventing the scattering of the quicklime throughout other portions of the apparatus. A few minutes after the introduction of the quicklime the machine will be in condition to receive its initial charge. I believe that there is one fact in this connection which is not generally recognized; that is, there must be considerable strength to the initial charge employed during the months of excessive dampness. If you employ a strong current from a large machine it will start the well-

dried secondary machine immediately, whereas a small charger will often fail under the same conditions. My static machines work every day in the year; they never fail, but are always ready for immediate action.

DR. WETHERELL, Philadelphia: For determining the presence of moisture in my machine I have been using a scale of chloride of cobalt. I saturate a piece of paper with a 4-10 saturated solution of chloride of cobalt. I place this piece of paper in the machine and by comparing it with a scale I am able always to tell just the amount of moisture in my machine. The color of the cobalt paper changes from blue to red. I have been using it for a year and find that it works very well.

DR. GORDON G. BURDICK, Chicago: One thing that nearly all have failed to mention, and it is an important matter, too, owing to the increasing use of the static machine, is the number of hours that it is in use. The manufacturers advise us to keep out of the machine while it is all right, but changes occur in our machines that render necessary a certain amount of ventilation. The nitrogen in the air is decomposed and oxide of nitrogen is liberated which will attack the lacquer and it begins to peel off, and the machine begins to lose its generating capacity.

Chemical dryers of all kinds inside of a static machine are extremely bad. This does not apply to the method of using calcium chloride used by Dr. Johnson because there is no possibility of any particles being thrown off and scattered all over the machine. In many cases where a machine refuses to charge I find on examination that the plates are covered with chemicals, retaining a certain amount of moisture. That is a very bad proposition because it causes us to lose about half the current generated.

There is no necessity of going to any particular trouble making a hygrometer. Almost every housewife has one, an ordinary ginger cooky, which is as good a hygrometer as chloride of cobalt or any other substance. It will indicate moisture in the air as well and as soon as any hygrometer. If you can bend that ginger cooky without breaking it there is too much moisture in the air for anything except the Wimshurst machine, which is not susceptible to moisture in any way, shape or form, up to the point of absolutely deluging it with water. I have seen the machine charge, and charge well, with the hygrometer standing up to 90°

because the machine transforms its energy through the agency of heat or the friction element.

I had the misfortune of owning a static machine and living on a boulevard where some fellow would pass up and down the street every hour or two with a sprinkling cart and soak everything. My plates were soaked, and as we lived on a corner where we did not get very much sunlight, the water would not evaporate, and I had all kinds of trouble with that static machine. I never knew for more than fifteen minutes whether the machine would work. Of course I tried everything in my attempt to control the water question, but failed to do so until finally I came to this. I put in an inlet and an outlet Schroeder valve. I connected my Victor electric pump to the outlet valve and pumped the air from the case into a nebulizer, allowing it to pass through a soda solution to remove the oxide of nitrogen. The fresh air first passing through a mineral wool filter and through a calcium chloride bottle so that the inside of the machine remained free from moisture and dust. At the same time I was getting fresh air in my case, removing the ozone from the case and thus preventing the accumulation. After I adopted that practice I had no more trouble with moisture, and there was no more difference in the working of my machine from day to day than there was in my coils.

Of course, the static machine is susceptible to changes in atmospheric pressure and within great limits. I do not agree with Dr. Johnson that the dryness of the machine has anything to do with the change in polarity. A machine that has stood east and west, or across the magnetic lines of force of the earth, will not charge, except during magnetic showers, and then you get the change in polarity. But a machine standing in direct relation to these lines of force will never give you any trouble. In Chicago the magnetic lines of force, and the earth currents sometimes cause a difference in the potential of 25 volts. The last time we observed the spots on the sun we could not use our machines for about four hours, and on investigation several of us found that there was a difference in the potential of the earth's currents of about forty volts. I also found that the needles were shifting. In two or three places in Chicago the magnetic lines of force practically go east and west for forty miles before they return to the normal line.

If you are unfortunate enough to be located over some bodies of iron, or where something is deviating the magnetic lines of force, you will find that your machine is changing polarity so often that you will regret ever having purchased the machine.

DR. G. P. GIRWOOD, Montreal, Can.: For the past two years we have been using a Wimshurst machine at the Victoria Hospital in Montreal, and have never had any trouble with it. Nor do we ever dry it out in spite of the fact that there is a big crack in the case at the bottom about an inch in width.

In this connection something occurred to me that I saw in our city when a friend of mine asked me to go and see his machine. It would not charge. I told him he wanted to get some calcium chloride to dry out the case, and he sent to a drug store asking the druggist to send some up to him as soon as possible, saying that he was in a great hurry for it. The stuff came and my friend immediately put it into the case. He waited for several hours but failed to get any result. He sent to me again several days afterward, and on examination he found that the druggist had made a mistake. Instead of sending calcium chloride he had sent calcium carbide, and that was the reason why my friend had so much trouble in getting his machine dried out.

DR. G. C. JOHNSTON, Pittsburg: We had a man in Pittsburg who wanted to dry out his machine. Somebody told him to get some calcium carbide, and he put one pound into the case of his machine. When he finally got the machine to generate the explosion following did about three thousand dollars' worth of damage, smashing the machine and everything he had in his office.

There is one other thing to which I want to call your attention. Dr. Burdick has made a suggestion that will get those who follow it into trouble. He stated that an ordinary ginger cooky will make an excellent hygrometer; but I predict that if you will use the cooky you will be in trouble constantly because the office girl cannot withstand the temptation. She will open the case, take out the cooky and let in more moisture than you look for.

DR. WAITE (closing the discussion): It pleases me greatly that my paper has brought out so interesting a discussion. Indeed, it seems that we can all speak feelingly from experience as to the effect of vapor on the static machine.

Referring to the different kinds of dryers—some stated that they had used heat. When this is done more vapor is formed, and unless the case is opened in order to allow the vapor to escape there will be more trouble than ever. Quicklime is very good as it absorbs the moisture and nitric acid fumes, but unless it is carefully watched the machine will look like a miller's shop, owing to the disintegration of the lime into fine powder. Calcium chloride unless rebaked contains more or less water and it should never be used without thorough rebaking. If this precaution be not taken, the plates, metal and insulating parts become covered with a sticky substance, the nature of which has not been determined. If, however, rebaked calcium chloride be used very little trouble will be experienced.

A physician in New Orleans had the same sad experience as the one in Pittsburg in using calcium carbide instead of calcium chloride—an explosion followed that wrecked his machine and office, and so I would say, beware of calcium carbide.

Referring to the care of the machine, the following instance will show that too great zeal is not desirable when applied to the inside. A physician in Philadelphia had a machine that suddenly stopped working. We had much correspondence to and fro but all to no purpose. Finally he telegraphed for me and I went on to Philadelphia. On my arrival I was much surprised to find the machine working. Investigation proved that the cause of all the trouble was that the maid, without his knowledge, had opened the doors of the machine and washed it out so as to have it nice and clean! When he discovered this he opened the machine, allowed the air to pass through and in a very short time it started.

Mention has been made of the Wimshurst machine. It will charge, but it does not give as long a spark considering the diameter of the plates. A thirty-inch plate will never give more than a five or eight-inch spark.

THE DEVELOPMENT OF THE SKELETON.

BY P. M. HICKEY, A.B., M.D.

The clavicle is the first bone in the body to show ossification. This appears about the fifth week, as also the centers for the inferior maxillary. In the seventh week appear the centers for the ribs, scapula, humerus, femur, tibia, palate, and superior maxilla. The next seven days show the development of the ulna, radius, fibula and ilium.

The youngest specimen which I could obtain for radiography belongs to the ninth week, as we can make out the centers for the lamina of the vertebræ, as far as the fourth dorsal.

The clavicle and ribs are very distinct, as also the superior and inferior maxilla.

In a lateral view of the same fœtus we see the beginning of the occipital bone, as also the metacarpals, the ungual phalangeal bones, the long bones of the arm and leg, the ilia and the metatarsals.

Another plate shows the centers for the lamina of the vertebræ showing the length of the dorsal region, while the centers for th bodies of the dorsal vertebræ are barely perceptible. The lateral centers of elongated shape for the frontal bones, and those for the nasal bones are plainly seen.

The metatarsal bones can be more plainly seen, the occipital center has increased in size, and the nasal bones are more easily distinguished.

The dorsal view of the same fœtus has the first centers for the sacrum. In a fœtus of three months the center for the ischium is discernible, and the frontal bones are extending toward the vertex. A little later the condyloid portions of the occipital bone appear.

In a plate of a fœtus of four months, the parietals show particularly where the shadows of their edges coalesce, also another center for the axis, and an additional center for the sixth cervical vertebra are plainly shown.

A plate of five months shows the bodies of the vertebræ, particularly the mid-dorsal, are perceptibly wider, showing approaching union with the lamina. In a later plate the ischia and more prominent centers for the sacrum can be seen.

At twenty-two weeks more of the phalangeal bones, both of the hand and foot are to be seen, while the centers of the mid-dorsal vertebræ have united.

At six months additional centers for the cervical vertebræ are now present, while the frontal bones have developed so as to show a bony plate extending up to the vortex of the skull. In the multiplicity of shadows cast by the sphenoid and its neighboring bones we are unable to positively differentiate the various osseous structures without the aid of the stereoscope.

At seven months we find the os pubis with its shadow adjacent to the more developed ischium, while the fan shape of the ilium is more pronounced. The centers of the lumbar and dorsal vertebræ have united.

In the hand of the seven months' fœtus the metarcarpals and phalangeals are all plainly seen, as well as the difference in density between the medullary and cortical portions.

At full term in a child which was viable, we can make out the heart, the liver, the spleen, and the coils of the intestines as they are rendered more prominent by gaseous distention.

In the hand and wrist of the child of five years is shown the lower epiphysis of the radius which usually appears in the second year. The epiphysis of the ulna is not yet visible. Of the carpal bones we distinguish the os magnum, the unciform, the cuneiform, and the as yet faintly showing semi-lunar. The trapezium which, according to our anatomies appears in the fifth year, is still invisible. The epiphyses of the metacarpals are distinct from their diaphyses. If the thumb, in contrast to the other metacarpals, has its epiphysis adjacent to the carpus. The first and second rows of the phalangeal bones show the epiphyses as distinct disks. The epiphyses of the ungual phalanges are just perceptible.

At eight years we find the epiphysis of the ulna can be seen, much later than is the time commonly assigned. In the carpus we find appearing the scaphoid, trapezium, and at the age of ten years we find a second epiphysis of the first metacarpal, confirming the statement of Allan Thompson in the Journal of Anatomy,

1869, in which he states that there are often three centers for this bone.

At fourteen we find the pisiform more clearly differentiated from the cuneiform when viewed stereoscopically. The carpal epiphysis of the first metacarpal has united with its shaft.

At seventeen we find that the phalangeal and the metacarpal epiphyses have united with their diaphyses. This is two to three years before they are ordinarily given as uniting. The union of the ulna with its styloid process is about complete, while the line of separation at the lower end of the radius is still quite distinct. The sesamoid is also seen.

Of all parts of the body the development of the elbow is perhaps the most important, from a practical standpoint, as mistakes in regard to its epiphyses have been made more often than in the radiographic interpretation of any other part of the body.

At eight years of age we find the internal condyle of the lower end of the humerus showing ossification. The upper epiphysis of the radius is seen as a small shadow continuous with that of the coronoid process of the ulna.

At nine years this disk is seen to be sharply differentiated.

At ten in the anteror-posterior position we see the center for the olecranon showing through the thin olecranon depression. The internal condyle of the humerus is ununited. There is also differentiated a nucleus for the internal articular surface. The trochlea is more developed.

In a lateral view can be seen at once the beginning of the olecranon.

At eleven the condyles have increased in size while the epiphysis of the radius is still distinct.

At the age of fourteen we find a second center for the olecranon not noticed in descriptions of the ulna, and ignorance of its existence might lead to serious error. That this secondary center is not rare is shown by a slide made from a lad a few months older, where the larger and smaller centers are in the process of union.

At fifteen the tip of the olecranon is fully formed, but as yet unjoined.

At sixteen this piece of bone is half joined to the shaft producing an appearance which has often proved misleading. In

another negative, at the age of fifteen, I have found almost the same appearance. The separation of the radial epiphyses from its diaphysis is clearly discernible.

In a slide made from a seven-year-old boy, we see the upper epiphysis of the humerus which has formed from the fusion of the centers for the head and tuberosities. This is said to remain distinct until the twentieth year.

In the pelvis at five the trochanters have not yet appeared, the head is separated from the shaft. The ischium is distinct from the ilium, and the ischium and os pubis being still ununited produce an appearance similar to a pair of calipers.

The knee joint at eight shows the separation of the external and internal condyles of the femur from the shaft. This epiphysis shows at birth and persists until usually some time after puberty. The upper epiphyses of the tibia and fibula can be easily made out.

At eleven the lines of separation are not as distinct. A year or so later the epiphysis of the tibia project downward with a tongue-like protrusion which forms the tubercle of the tibia.

The lower epiphyses of the tibia and fibula are seen in a slide from an eleven-year-old boy. These persist for some time, the former uniting at eighteen and the latter at twenty.

In the fœtus at six months we find the os calcis appearing first among the tarsal bones. The metatarsals are all formed, but only part of the phalangeal.

The tarsus, like the carpus, is only partially ossified at five years of age. The lower epiphyses of the tibia and fibula are well shown. The distances between the tarsal bones are so great that plastic operations at this age are possible. The phalangeal epiphyses are quite distinct, especially the first and fifth.

At seven we find the space between the tarsal bones to be less than in the preceding slide. The astragalus is assuming more of its characteristic shape.

At eight the tarsal bones more fully fill the tarsal space and the epiphyses of the metatarsals can be definitely made out.

At age eleven we see the beginning of the epiphysis of the os calcis, which at age twelve is fully formed but still unjoined.

At age thirteen we have the beginning of the union of the epiphysis with the body of the os calcis and the space between the

tarsal bones approaching the distinct development of the adult foot.

The purpose of the writer in presenting these slides is obviously not to attempt any complete description of the development of the skeleton, but to demonstrate how easy it is to study the development of the bony framework from its inception in the fœtal life up to completion by means of radiography. We are accustomed to read the descriptions in our anatomies of the periods at which the several bones ossify. I rather fancy that to many of us, in our student days, such descriptions had but little meaning. The bulk of information which had been collated up to the time of the Rœntgen ray studies upon this subject was brought together only by the most laborious and painstaking dissection. From the standpoint of the embryologist much of this work will have to be rewritten, as some statements in many of our text-books are fallacious. It is important that careful radiographic study should be made of specimens of known age in order to definitely decide many of these anatomic points.

In making radiographs of specimens, all known measures to secure detail and contrast should be employed. It is needless to add that the original negatives from which these slides were made possess a wealth of detail which is practically only hinted at in what is seen upon the screen. The making of a proper lantern slide is a matter of suitable exposure, coupled with proper length of development, and unless both factors are harmoniously adjusted loss of detail is sure to result.

We may summarize as follows:

1. Radiography offers to the embryologist a simple method of studying the formation of the bones of the body.

2. Radiography offers to the anatomist a simple method of studying the epiphyses of the bones.

3. The statement in our anatomies concerning the development of the bones should be revised according to the knowledge gained by radiography.

4. Reproductions of radiographs of the fœtus at different ages should be inserted in our anatomies in order to elucidate what is now a somewhat neglected and imperfectly understood topic.

5. Radiography for diagnostic purposes of an injured joint of a child should always be compared with radiographs of the corresponding *uninjured* joint.

DISCUSSION.

DR. G. P. GIRDWOOD, Montreal, Can.: *Mr. President*—I wish that someone else who is better acquainted with the development of the skeleton had been asked to open the discussion on this very excellent paper. The radiographs the Doctor exhibited are beautiful and form a classic history of the development of the skeleton, showing the manner of development and also the time when each bone begins to form and when the formation is completed. As he suggested such a radiographic history of bone development may be very useful for comparison with diseases of bone in children of the same age. It will also give you an idea as to whether the development is progressing normally in children who are backward in their growth, children who are the victims of the diseases of malnutrition.

But here is another feature in this matter that is of prime importance, and that is the determination of the age of a child. Such a determination may have to be made under various circumstances, especially in medicolegal questions. For instance, a child who is born as a posthumous child or is the heir to a large sum of money or to a title, may have here a very important piece of evidence that is positive and must be accepted as such. That is an essential matter to the child, to the mother and to all the family. In England, I believe, the courts have determined that a child may be carried for ten months so that posthumous children have been enabled to succeed to titles and estates of which they otherwise might be deprived. Of course, in this country that would not apply to such an extent as in England.

In the study of malformations of the skeleton these radiographs would be especially useful. I have done a little work in this line, and have a few skiagraphs which I would like to show you. The first is a double-headed monstrosity. In the second, the occiput is grown on to the upper lumbar vertebræ. The dorsal vertebræ are crowded into the commencement of the cervical vertebræ. The ribs are hanging down. In the third, there is a con-

genital absence of the fibula in one leg, and there is also a considerable bending of the femurs. The next is a case of congenital rickets. All the bones are short and present large extremities. The ribs are thickened at their ends and are nodular. The ossification of all the bones is very much delayed. The bones which are likely to come into use as soon as the child is born are the ones which will ossify first. First, the clavicle; then the lower maxilla, and third, the upper maxilla. The lower limbs ossify last because they are the bones brought into use last.

In the case of the double-headed monstrosity the ovum was split at the upper end and consequently two heads developed and two sets of vertebræ. One set of ribs passes downward on either side, and a third set is developed from the two spinal columns, and are united in the middle.

The last case is a very remarkable one of a fœtus born at full term. The head, upper and lower extremities are drawn into the body. The skiagraph shows that all the bones are there but developed inward instead of outward. By making skiagraphs of these cases it is possible to get a correct picture of the bony skeleton without disturbing the specimen in any way, thus making it available for further study.

Dr. Chas. L. Leonard, Philadelphia: I have a few slides that will be of interest simply because they show the study of anatomy and deformities with the X-ray. The first shows a normal fœtus at term. I had the blood vessels injected with a mixture of red iodide of mercury and starch. It also shows the development of the bones at term. The vessels were injected by means of air pressure, driving the mercury into the most minute capillaries. You can see distinctly the nutrient arteries of the bones as well as all the other vessels. The anastomoses of the vessels at the symphysis pubes and about the knee joint show very plainly.

The second case is one of a cretini dwarf 21 inches high. You can see striæ extending across the upper end of the tibia and also the femur and in the epiphyses. We do not know their significance, but it is possible that they are indicative of the age of the fœtus like the lines in the horns of a deer. You see them more plainly in the second slide, which is a skiagraph of the foot of the same person. The lines of ossification are concentric with the exterior of the bones. These slides when compared with those of

normal bone development shown us by Dr. Hickey afford a very interesting study of this condition.

DR. JAMES B. BULLITT, Louisville: I wish to speak on the last remarks made by Dr. Hickey concerning the importance of determining the time when union between the epiphysis and the diaphysis occurs. This is important in cases of injuries about the joints. I have had some experience along this line, and I know that those who are not accustomed to radiography, or are not familiar with the development of the bones, or when the union between the epiphysis and diaphysis occurs, are oftentimes inclined to be very much mistaken in the interpretation of what is seen in a radiograph. This certainly is one of the important aspects of this subject considered from a surgical standpoint, one which has not received the attention it merits. I believe that it is essential that all anatomists work out a complete radiographic history of the growing skeleton, and Dr. Hickey is to be congratulated for having done so much work in this connection. Before many years work of this kind will appear in all our text-books on anatomy, and they will not be considered proper text-books to put into the hands of our medical students unless they contain this radiographic history of the growing skeleton.

DR. HICKEY (closing the discussion): I was very much pleased with the discussion and also the slides shown. After I was embarked on this work I became very much impressed with the fact that a considerable amount of work must have been done by our earlier anatomists in order to arrive at their data in this matter of bone development. They must have done many and most laborious dissections before they could determine where and when the centers of ossification appeared in the various bones of the body of so small a being as the fœtus. Science certainly has made great and wonderful progress when it can arrive at these same conclusions without having to resort to such time-consuming measures. Those of you who have the material should take this work up, working on specimens of a known age so that we can obtain definite data that will be useful to all. It is not sufficient to make simply one radiograph of a joint. We must make many and at certain known ages. Studies should be made upon a large number so as to arrive at a standard.

THE EFFECTS OF X-RAYS UPON LOWER ANIMAL LIFE AND THE TUBES BEST SUITED TO THEIR DESTRUCTION.

BY DR. KENNON DUNHAM.

1. The immediate object of this research was to ascertain what effects, if any, X-rays have upon several of the lower forms of animal life; to discover if any of such organisms are destroyed by X-rays; and if so, what technique best produces such destruction.

2, The reason for such research is based upon the analogy existing between such lower organisms and the new cells of a malignant growth. What I really wish to establish is a scientific method by which to determine the best form of tube with which to treat such growths; and it seems but fair to allow, upon such analogy, the supposition that the condition of tube that is most destructive to one of these forms will be most destructive to the other.

This does not mean that the most destructive form or arrangement of tubes will be the best for the treatment of epitheliomatous or sarcomatous conditions, for therapeutically you must consider also the effects upon healthy tissue, upon the nerves, the circulation, etc. It simply means that one may have found the first step in considering such treatment; that is, the destruction of the malignant cells. The organisms I chose for my experiments were: *Chilomonas, Paramoecium aurelia, Paramoecium bursaria, Cryptomonas, Rotifera, Arcella.*

3. The only other account of research work along the same line that I have been able to find was that published in Berlin, in 1899, in the Archiv für die gesammte Physiologie des Menschen und der Thiere, by Dr. F. Schaudinn. But Schaudinn's work differs from mine in two important particulars, he is concerned about the number and nature of these lower organisms affected by X-rays, and how they were affected; I., about the tube and conditions best effecting the de-

struction of any of them. Again, his technique, his apparatus, and the time given to experiments differed from mine. The modern improvements along these lines permit my reducing to minutes the fourteen hours he exposed his specimens to the light. The organisms which he found were destroyed were: *Amoeba princeps,* 25% died; *Amoeba lucida,* all died; *Pelomyxa palustris,* all died; *Gromia oviformis,* died; *Actinosphaerium eichhorni,* died; *Chilomonas paramecium,* died; *Cryptomonas ovata,* died; *Euglena acus,* died; *Oxyrrhis marina,* died; *Spirostomum ambiguum,* died; *Cryptomonas* was not destroyed in my experiments. Otherwise, these reports mutually prove one another.

4. I spoke of the difference in technique employed by Schaudinn and myself. It is in regard to this that I find the greatest care necessary. Perhaps the points to be most insisted upon are the use of control specimens; the selection of the best rays of the light, as well as the best distance between the tube and the specimen, and the proper method, number and times of exposure.

As to control specimens, every possible attention has been paid to them throughout my experiments. Never have I exposed a specimen to the rays, without placing another specimen, as nearly similar to the first as possible, in a lead box safe from the rays. When a specimen has been exposed to the sun-light for microscopical examination, its control has been placed as nearly as possible in the same light even to the condenser, where a condenser has been used. In shallow water the specimens are very susceptible to strong light.

There is quite a difference to be noted in the different rays, the strongest being those directed from the center of the anode plate in a line perpendicular to its face. I also soon discovered that the best results are obtained if a sheet of lead be rolled into a cylinder, and the rays directed through this. I considered this focus tube and the proper direction of the rays of great importance. The most destructive rays were produced by a medium low tube excited by a heavy electrical discharge which had been passed across spark gaps, or through other resistance sufficient to produce rays of great

penetrative power. Such a tube would give a clear picture of the hip of a man weighing 170 pounds in three and one-half minutes. Very low tubes which show no bones but only the outline of the hand upon the fluoroscope have shown no effect upon the organisms, nor have the ultra-violet tubes influenced them. Very high tubes which were not heated by the heaviest discharges of my apparatus after ten minutes of exposure, gave very poor results. I used an 18 inch coil.

We have now seen how to get the best rays; I find the distance such rays must travel from the tube to the specimen to be also a matter of great importance. Regarding this, several important conditions must be considered. It is a well known fact that a high potential current passing through a partial vacuum tube induces a secondary current upon the outside of that tube. This is the principle upon which high frequency tubes are operated. The high frequency discharge is in some way very destructive to these organisms if brought in too close relationship with the specimen. The destructive effect may be due to the liberation of ozone (a great deal of which is produced), or it may be due to some form of electrical discharge direct. A Crook's tube is a partial vacuum tube and has passing through it a high potential current; and, therefore, has an induced or high frequency current upon its outer surface, though this induced current is not nearly so strong as that produced by the high frequency apparatus. In all experimental work it is necessary to make the tests as simple as possible, I have tried, therefore, to eliminate the possibility of this induced current affecting my experiments. The high frequency surrent, which is, as I have said, a much stronger induced current than that produced with the X-rays; had no effect upon the specimen when removed from it five inches. For this reason the distance of my X-ray tube from the specimen has never been less than five inches. I soon found that the closer the tube, the more potent the rays. As five inches was considered the closest I dared to bring the tube in absolute safety, I early adopted five inches as the standard distance.

My method of exposure has been to take a small thin rectangular frame of brass such as fits easily upon the ordi-

nary microscopic slide, a counting cell in fact, of the Sedwick-Rafter type as modified by Calkins, Jackson, and Whippler. This brass rim is cemented to a glass slide and the cell is 50 mm. long, 20 mm. wide, and 1 mm. deep. The superficial area thus is 1000 sq. mm. and contents 1 cc. This is used for the microscopical quantitative examination of water. As can be seen this presents to the rays a very broad surface with little depth and is easily examined under a low power microscope without a cover glass. The greatest difficulty is found in keeping sufficient water over the organism as evaporation is very rapid. This was obviated by having a small cup of water with a piece of absorbent cotton twisted into a wick to extend from the cup to the receptacle on the slide. The slide is placed lower than the surface of the water in the cup, (thus gradually drawing the water to the slide). If the water in the cup were much higher than the slide, the slide would be flooded, and the control must be arranged with similar care. The number of exposures varied from three to fifteen. The duration of each was from three to twenty-one minutes. The time allowed between exposures was at first twenty-four hours, later only one hour. When the duration of each exposure was longer than I cared to use my tubes, I allowed an interval of five minutes after each exposure of three minutes. I think that this covers the matter of the technique used throughout the experiments. Perhaps it would be well to take a typical experiment and follow it through, since time will not permit a detailed account of all of those from which my facts have been drawn. I chose one in which any deviation of the technique would give noticeably poorer results.

5. Apparatus. Coil 18 inches, mercury turbine interrupter drawing 5½ amperes from a 64 volt storage battery, 2 spark gaps of 3 inches each, 2 vacuum tubes, one high the other low, in series with a medium low Gundlach tube of 8 inch diameter. The same apparatus worked in a similar manner has taken a good picture for me in three and a half minutes. The specimens to be treated were arranged on a slide and controlled as I have previously described, the tube being focussed through the lead cylinder, from the centre of the anode, with the face of the tube five inches from the slide.

Upon the slide were:

1. *Chilomonas.*
2. *Paramecium aurelia.*
3. *Paramecium bursaria.*
4. *Cryptomonas.*
5. *Rotifera.*
6. *Arcella.*

The extract from my notes reads:

Date.	Interval.	Exposure Time.	Specimens.	Control.
Nov. 10	.....	First 3 min.	No change	No change
" 10	1 hr. later	Second 3 "	" "	" "
" 10	2 " "	Third 3 "	A little stiff	" "
" 11	.....	Fourth 3 "	1 and 2 no mobility, the rest seem sluggish	" "
" 11	1 hr. later	Fifth 3 "	1, 2 and 3 no mobility; 4, 5 and 6 possible sluggish	" "
" 12	.....	Sixth 3 "	1, 2 and 3 dead; 4, 5 and 6 no change	" "
" 13	.....	Examination	1, 2 and 3 dead; 2 fatty degeneration with high power; 4, 5 and 6 no change	" "
" 15	.....	"	1, 2, and 3 not seen; 4, 5 and 6 no change	" "

This is an example of research experiments which have been verified by me many times, and I consider that it shows the best method of obtaining the most decided reaction. With higher or lower tubes, with a greater distance between the specimen and the tube, focussed differently, or focussed without the lead cylinder, the results are less marked, or the necessary time of exposure is longer.

As a general law living tissue is stimulated when subjected to a properly attenuated destructive force. If this was so with regard to the effect of the X-ray upon the specimens, I failed to note it; but I consider that further work along this line may prove that a tube properly focussed, with the current exciting the tube to the proper rays, may produce increased activity among these organisms. But I have failed to note any such result.

Another deduction made from these experiments is that they who claim that the cathode rays and not the X-rays are essential to the destruction of epithelioma, are probably wrong. The same tube when excited by a greatly resisted current, is

much more destructive than when excited by a current of lower potential. The amount of the X-ray in the latter case is practically nothing when compared with the former. In the case of the current of lower potential too, the cathode rays appear to the eye much greater. Therefore, I believe the destruction is due to the X-ray.

6. Having discussed the technique most effective in these experiments; giving an illustration of a typical experiment; and drawn from it such deductions and observations as are best substantiated by all my work, I feel that we are now able to answer the questions asked at the beginning of the research.

First, What effect has the X-ray upon lower organisms? We have seen that some of these organisms are killed by the X-rays, while others are apparently unaffected by it. The Chilomonas, Paramecium aurelia and Paramecium bursaria, all forms of single cell life, belong to the first class; while Rotifera, Arcella, and Cryptomonas were unaffected by the light. Chilomonas were the most numerous and showed the first effect of the rays, and after being destroyed, gave decided evidence under the high power of fatty degeneration. The Paramecia were markedly affected but were not near so numerous. I noted no fatty degeneration in these specimens, but this was possibly due to lack of sufficient effort. In speaking of the effect of X-rays upon these organisms, we must note again that there was no stimulation prior to death.

The second question asked was, "Can any of these lower organisms be destroyed by the X-ray?" This question is almost answered in the first, but it is important to note here that through the use of controls and care in technique, we have eliminated as the destructive force, any other agency than the X-ray; the most possible of such other agencies being the sunlight, an induced electric current, and the cathode rays.

Question three. "What technique best produces such destruction" has been answered in detail throughout this paper. Should we confine our question to the use of tubes, we can sum up our deductions in three statements. First, the closer the tube to the object treated, the more destructive the rays. Second, lower tubes excited by small currents are not so de-

structive as lower tubes excited by heavier currents, which are resisted. And third, very high tubes have very little effect.

7. We have now reached our real conclusion. Since we have established what technique best produces destruction of certain lower cells by X-rays, and have acknowledged the analogy existing between these lower organisms and new malignant cells, we have decided (bearing in mind that the possibility of destroying healthy tissue is to be eliminated) that the best rays to destroy epitheliomatous and sarcomatous cells are given off from the lower tube excited by a heavy current with much resistance.

DISCUSSION.

DR. WM. H. DIEFFENBACH, New York City: In connection with the excellent paper we have just listened to it occurred to me to bring something before this society which I read in one of the German publications that came to my table. The name of the author has escaped me. The organisms he used in his tests were spermatozoa of rabbits. His experiments were carried out with the view of determining the effect of the X-ray on fecundity of the animal and also on the spermatozoa themselves. This is not exactly in line with Dr. Dunham's work, but it is interesting for us to know what our friends on the other side are doing. One set of animals were exposed to the X-ray and another set were kept for control. The rabbits were exposed to the ray for a number of hours and then opportunities were afforded to observe their sexual powers. He found that the sexual power of rabbits exposed to the ray for a certain length of time was lost and that the spermatozoa contained in the testes and seminal vesicles were destroyed. The control animals were absolutely normal in every way. This is quite an important point for us to know so that no unnecessary exposures will be made.

DR. HENRY E. WAITE, New York City: The description the doctor gives of his technique is very misleading. He speaks rather indiscriminately of a high tube, a low tube, a hard tube and a soft one. These distinctions really mean nothing, as the only difference between a high tube and a low one

is that the low tube contains more gas than does the high one.

That which concerns us most, however, is the penetration. The essayist spoke of a low tube with a high resistance. This is in reality a high tube and not a low one.

A tube containing a large amount of gas and connected directly with the coil or static machine without a spark-gap, will not generate much, if any, X-radiance. If a spark-gap be used, however, the effect is very similar to that obtained when a dam is built for increasing waterpower—the higher the dam the greater the pressure of the water. Similarly, the wider the spark-gap the greater the accumulation. When the current passes into the tube it forcibly displaces the other molecules—pushing them out of the way, impinges directly upon the platinum plate and so generates the X-ray. I have seen tubes that would back up a spark of eight or ten inches and yet their penetrating power was very slight because they were not correctly focussed.

A good tube is one with a perfect focus and well balanced vacuum. It is, however, almost impossible to produce such tubes uniformly, for the reason that when the electrodes are melted into the tubes it is difficult to hold them in perfect position. An extra fine tube is found only once in two or three hundred tubes. With such a tube the heart of a large man can be seen twenty-five or thirty feet from the tube.

It is incorrect to speak of high tubes and low tubes because these terms do not convey any definite information. We should always determine the penetration of a tube and use that as a guide. When the resistance of a spark-gap is used to accumulate force in order to overcome the resistance of the large number of molecules contained in the low tube, we practically have a high tube and not a low one.

Reference has been made to a little bubble that appears on the platinum. Dr. Graves, of St. Louis, said that when this is found on the platinum it is positive evidence that the tube is a good one. He called it the "Star of Bethlehem."

Dr. Dunham (closing the discussion): I wish to thank you for your consideration of my paper. I had overlooked the article Dr. Dieffenbach mentioned. I have attempted in a feeble way to give you something that will be of value to you.

I give you the results of my work, and that is all. It is not a great work, but it is a link of the chain and as such may be of assistance to some other man working along the same lines. It is possible that after further research in this direction, I may come before you next year and give you something not in keeping with the results I have obtained. But I will continue in my efforts and hope that at some future time I may be in the position to offer you something more valuable.

In regard to the tubes: Dr. Waite said that a low tube placed in series with great resistance becomes a high tube. What I tried to make clear in my paper was that a low vacuum tube, or a soft tube, as he calls it, made high by resistance, is a very different proposition from a high tube. We do not get the same effects upon the organisms when a high tube is used that is noted from a low tube made high by increased resistance.

THE TECHNIQUE NECESSARY FOR MAKING GOOD DENTAL SKIAGRAPHS.

BY WESTON A. PRICE, D.D.S., M.E.,

Read Before The American Roentgen Ray Society, December 9, 1903, at Philadelphia, Pa.

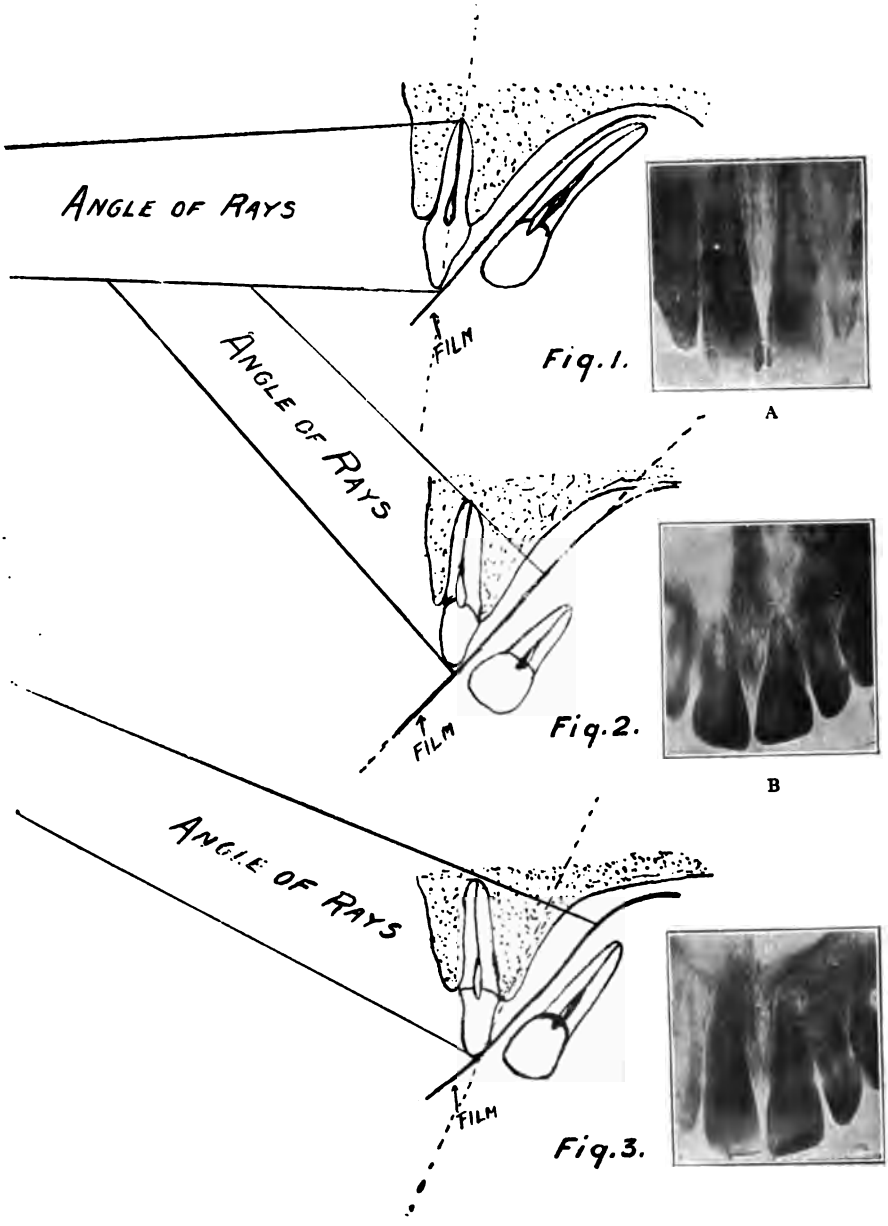
The procedure for making good dental skiagraphs is not much more exacting and difficult than many of the every day operations of both the dentists and the surgeon. There are doubtless other methods for obtaining excellent results that may be quite as good as mine, but I shall give as briefly as possible the technique I use.

The Generator. We must use a relatively high penetration and a large volume. The high penetration is essential because our contrasts are to be secured between all dense substances, bone and more dense bone, or tooth substance and root fillings, whereas in ordinary skiagraphy the contrasts are chiefly between flesh and bone. The large volume is essential in order to make short exposures, which are necessary to secure the best definition. These two qualities of high penetration and large volume make it necessary that we have a very powerful generator, for which I prefer a large coil and Wehnelt interrupter.

It is very desirable that the apparatus be so conveniently arranged that the patient may be seated in the dental chair which allows of a wide range of positions, with comfort to the patient, and firmness and steadiness of the head not easily secured in any ordinary chair. The difference in the result is about the difference between the photographic work of a man who holds his camera in his hand to make a bulb exposure and the man who sets up his tripod. It is a question of showing with exactness of definition and detail either the cellular structure of the bone and sharply defined alveolar walls, or simply a blurred indefinite outline of these structures.

The switch for turning on the current should be very conveniently arranged so that the operator can easily turn on and off the current while holding the film in position. In some cases I find that the patient can hold the film satisfactorily, but in most cases I can get better results by holding it myself.

The Tube. The selection of the tube is, if possible, more exacting than the generator. As stated before, the condition we are skiagraphing, and the information we require, are such as to require a tube giving a relatively high penetration. Of course the penetration of tubes is not in constant proportion to the spark gap they will back up, through quite regularly so with tubes exhausted from the same gases. For dental work we require a tube of penetration sufficient to make the bones of the hand look quite transparent and white, which will usually back up from a four to an eight inch spark gap. A very large per cent. of the failures in dental work have come from using too low a penetration. When locating abscesses, in order to produce a clear definition, we generally use a little lower penetration than for locating root fillings or broaches, or even impacted teeth, and all of these will be modified a little to advantage for old or young patients, using a little higher penetration for old patients. This quality of a high penetration tube is quite easily secured if you select the tube yourself from a quantity, which I generally do, or it can be entrusted to a good dealer whom you carefully instruct. These high penetration tubes, or so-called hard tubes, can often be secured from operators who do general X-ray work, for which they desire the medium and lower penetration, the tendency of tubes in use being to get higher. But tubes for this work must have another important quality which is much more difficult to obtain, and that is being capable of carrying a very large current without overheating the anti-cathode, or materially lowering the vacuum of the tube. The ordinary tubes with a thin or medium thick sheet of platinum as an anti-cathode are not satisfactory for the best results in dental work, because they will not stand this large volume. We should use a tube with some device for absorbing the heat from the platinum, which may be either backed with a heavy mass of metal or water


ANGLE OF RAYS
FILM
Fig. 1.
A
ANGLE OF RAYS
FILM
Fig. 2.
B
ANGLE OF RAYS
FILM
Fig. 3.

cooled. It need not be a circulating stream of water, but a reservoir of it in a special receptacle around the base of the anti-cathode. Some may ask, why not be content with using a tube giving smaller volume of X-rays and give a longer exposure? Because we cannot get the best definition showing the cellular structure of the bones except by avoiding the slight distortion due to the unavoidable movement of the parts from breathing during a longer exposure. A very slight movement of the patient is equivalent to a considerable movement of the tube, and is sufficient to destroy the fine definition of the cellular structure of the bone. I prefer a volume such as will photograph the hand in one-half second. The tube stand must be such as will allow of an easy and wide variation of positions and be free from vibration.

The Photographic Films. The difference in the densities of the dental structures between which we must produce photographic contrast is so slight that it makes it practically impossible to get choice results with ordinary photographic film. We must pile up the slight contrast by using several layers of emulsion on the same films. Nearly four years ago I put a great deal of work on the production of such a film which has given excellent success, and I believe it is in general use for this work, and is being manufactured by the M. A. Seed Dry Plate Co., of St. Louis. It has three layers of emulsion, one upon the other, and all are acted upon at once by the X-rays. It can be secured from them direct by specifying my name or the special dental film. The celluloid is thick enough to prevent curling, and yet sufficiently flexible for the purpose, and is selected from specially prepared smooth polish transparent stock, free from scratches.

The conditions under which we use it require it to be covered with a waterproof, light proof, flexible container, and for this I have found nothing so satisfactory and convenient as the unvulcanized black dental rubber, which can be secured at any dental supply house. Buy the thin made by Dougherty. For two reasons I put in a sheet of sensitive bromide paper with its face to that of the film: To protect the emulsion of the film from the action of the sulphur of the rubber, and to give me a positive of the case within one or two minutes,

which may give the information desired, and will show for sure whether the negative covers the area desired, and if the exposure is right. These dental films are made up quickly by placing a sheet of 4 x 5 or 5 x 7, sensitive bromide paper on a sheet of film, the same size, face to face, and then taking the paraffined linen from one side of the rubber, and touching the edges of the sheets together for a 4 x 5. They will stick very tenaciously, then folding this over the films and bromide paper press the edges together to seal them in. Mark a 4 x 5 into nine small divisions varying a little in size, and cut through with shears and fold the rubber from the film side over the edge to touch the rubber of the other side where it will adhere tightly. Snip the sharp corners off the film and fold the rubber over them.

These films will keep in good condition for weeks, until needed. To keep them from sticking to each other place in a piece of paraffined linen taken from the outside of the rubber sheets.

When making the exposure I place a small number (the figures made from fine lead fuse wire and stuck onto a piece of heavy paper with mucilage) against the rubber where it will stick. This number is recorded with the record of the case, and appears not only on the negative but on all prints made from it. This is most important in dental skiagraphs which are so similar, and a quantity of them soon accumulate. As this film is extremely sensitive to daylight as well as to X-rays it is exceedingly important to take the greatest care that it is kept in a lead box, and not in a hot place, and when preparing use the most subdued ruby light. This is very essential.

The Exposure. For making the exposure I prefer the patient to be in the dental chair because of the ease in adjustment of the patient, and rigid support for the head. Much skill is required to place the film and tube in the proper relations to the teeth so as to produce a correct shadow of the parts without distortion. We all know how seldom our own shadows represent our true height or shape because the source of the light and the surface receiving the shadow are not in the proper relations to the object casting the shadow. Each

of these three factors must be in correct relation to the other two, but one of them, the teeth and surrounding structure casting the shadow are by their peculiar position practically fixed and the others must be adjusted to them. The shape of the arch prevents us placing the film receiving the shadow in the best position to receive the shadow, viz.: in a parallel plane with the teeth. This produces a distortion which must be overcome by placing the source of light in just the position that will shorten the shadow just the amount that will correct the elongation, produced by the film not being parallel to the roots of the teeth.

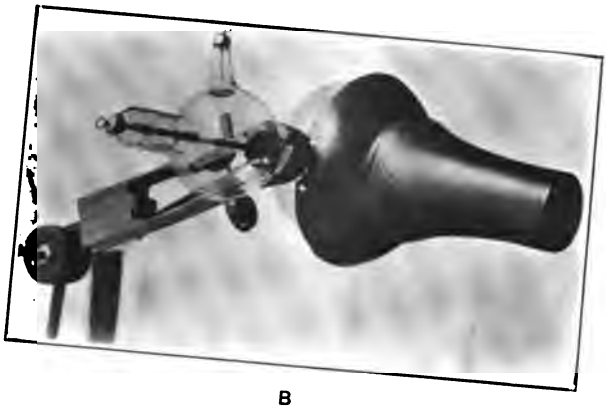
We do not have this trouble with the lower bicuspids and molars, but do with the lower cuspids and incisors and with all the upper teeth. The correct image can be secured in two ways; by holding the film away from the crowns of the teeth the same distance that it is away from their roots, or by elevating the source of the rays. The former is more difficult and the results not more satisfactory. These three diagrams, Nos. 1, 2, and 3, will illustrate the distortion and how to correct it. No. 1 shows diagramatically the relation of the tooth and film to each other and the result of taking a skiagraph with the tube opposite and at right angles to the plane of the teeth, and shows the distortion by elongating the shadow of the root. The skiagraph A. opposite was made with the tube in this position, and you will note the very long roots, nearly twice the correct length. Fig. No. 2 shows the distortion by placing the tube so that the rays fall at right angles to the plane of the film, thus greatly shortening the shadow of the roots, and the skiagraph B. opposite shows the same teeth as A. but taken with this position of the tube. The next Fig. 3 shows the correct position for the tube in order to produce a shadow of the teeth that will have the minimum of distortion, and the skiagraph C. opposite shows the same teeth as A. and B. taken from this position, and you will note easily the difference in the result. This correct position of the tube is easily ascertained in two ways. It is just half way between the two positions which are at right angles to both the long axis of the teeth and the film. This position is also at right angles to a plane half way between that of the long axis of the teeth and the

film. This simple rule holds for all teeth and for any shape of arch, except that care must be taken not to curve or bow the film unnecessarily. There are a few positions like the lower anterior incisors and cuspids where it is easier sometimes to place the film in a plane parallel to that of the teeth and place the tube at right angles to both, than to adjust as above. Occasionally impacted third molars are difficult to place the film for, owing to the sensitiveness of the fauces. Dr. Dwight M. Clapp suggests using a mouth mirror frame to hold the film. I believe this is a good idea though I have never had a case where I could not hold it quite comfortable with my finger.

About a year ago I feared I would have to give up the use of the Rœntgen rays for a time because my hands were getting so sensitive to irritation from it, but I was fortunately able to correct the difficulty very satisfactorily. I devised an opaque cloth and an opaque rubber sheeting and opaque rubber gloves that have quite perfectly relieved the trouble. Since the effect of the X-rays is cumulative the operator is in a hundred fold more danger than the patient when making dental skiagraphs. I have never had a sign of irritation of any kind on any patient from making dental skiagraphs. To protect my hand from the X-rays when holding the film I place a piece of the opaque rubber sheeting over it, just before turning on the current, and I have a shield over the tube made of the same material for part of my work. When experimenting or working around the tube the gloves are a perfect protection. This skiagraph Fig. 4 shows one hand with a glove and one without. I have devised special opaque tube shields to protect the operator and body of the patient, which are shown in Figs. 4B and 4C.

Special Development. This triple coated film requires special development. In order to secure the contrast of all three layers of the emulsion without fogging the upper one it is necessary to have the temperature and strength of the developer very carefully adjusted. About 75° in the winter and 70° in the summer, and the development must be slow enough to allow the lower layer of emulsion to be acted upon before the upper one is over developed. Since our picture is purely a shadow I develop for strong contrasts producing

A
FIGURE 4



B
FIGURE 4

C

FIGURE 4

FIGURE 5

dense negatives and take from 20 to 40 minutes for development. I prefer a Metol-Hydroquinon developer because with the necessary slow development it is very free from stain. There is a tendency for a lustrous thin metallic deposit of silver to be deposited on the surface of the film after long development, which if not removed very greatly impairs the printing qualities of the negatives. It can be quite readily removed by rubbing with a tuft or ball of cotton. The bromide paper will develop in from half a minute to two minutes in the same developer that the negative is developed in, but must have a special fixer or velox fixer. The film should fix for at least thirty minutes, and the negative should not be held in the strong light of an electric or mantle gas light until dry. The image will not appear distinctly on the back when developing.

Care should be taken to wash the film in running water for five minutes between the developer and fixer. I use the following developer and fixing formulas:

Developer.

A. Water	16 oz.	B. Water	16 oz.
Metol	30 gr.	Potassium Bromide	15 gr.
Hydroquinon	30 gr.	Sodium Carbonate dry	130 gr.
Sodium Sulphite dry	130 gr.		

Use equal parts and for over exposures dilute with equal parts of water. Use only distilled water.

Fixer.

A. Water	96 oz.	B. Water	32 oz.
Hypo	2 lbs.	Chrome Alum	2 oz.
Sulphite of Soda (crystals)	4 oz.	Sulphuric Acid	¼ oz.

Pour B. into A. while stirring A. rapidly.

I will show a few typical hard cases and how to take them, also illustrate some of the likely sources of failure.

I will show a few lantern slides illustrating the information that may be secured and bring out some details of method as they are shown.

Fig. 5 shows a collection of diseased roots, the first two with extensive absorption, and the last two with extensive deposits on the roots.

Fig. 6 shows the cuspid and bicuspid regions of both upper and lower jaws of a boy 12 years old. The temporary cuspids and molars are all in place and it is a problem whether their successors will ever erupt. The skiagraphs show a strange condition. The cuspids are all forming but as you see only half of the bicuspids are. Only one of the four right bicuspids is formed.

Fig. 7 shows the finding and the steps of correction of a strayed lower bicuspid. A. shows this second bicuspid more than an inch from its proper position and on its side. The gum line is dotted in. B. shows the anchorages to draw it up into position, and C. shows it tipped up to its proper direction. D. shows its articulation which has since improved.

Fig. 8. A. shows the location of the unerupted cuspid and its relation to the temporary marked T. B. shows the same after some space had been secured and an opening made to the tooth. C. shows the first anchorage; it is too near to the neck of this tooth, and D. shows that the last anchorage pit is in the crown is good position. It will not be long now before it will not require the X-rays to see the tooth.

Fig. 9 shows two very interesting lower third molars. A. shows a third molar impacted against the second molar and causing a great deal of severe neuralgia by the impingement of the roots of the third molar as they are developing backward against the inferior dental nerve, the channel for which is shown. B. shows a remarkable condition. The patient had a fistula on his face near the corner of the jaw, the cause of which could not be determined by his physicians. The skiagraph shows an imbedded third molar which has extensive decay and is abscessed at the end of its roots, from which abscess the external fistula came.

Fig. 10 shows the condition of a girl, age 14, where both the permanent laterals and cuspids were missing. The laterals have never formed and the cuspids have developed forward and are lying over the centrals.

Fig. 11 shows two cases of tumor. A. was thought to be an osteoma but proved to be a supernumerary developing between the cuspid and lateral. Case B. was thought to be a supernumerary tooth developing over the cuspid and lateral, but proves not to contain a tooth but is a sarcoma. Note how the roots of

Lower Left Lower Right Upper Left Upper Right

FIGURE 6

A B C D

FIGURE 7

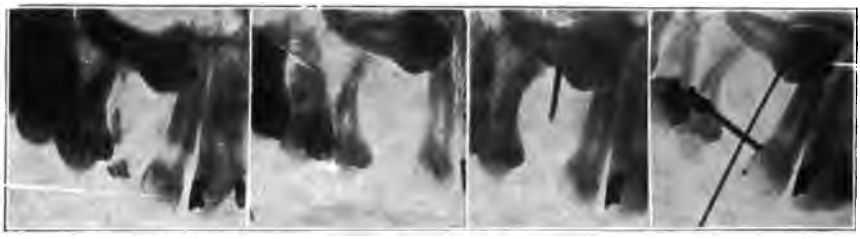


FIGURE 8

A FIGURE 9 B

FIGURE 10

A FIGURE 11 B

A FIGURE 12 B

A FIGURE 13 B

the cuspid and lateral are pushed apart and the bone is less opaque.

Fig. 12. A. shows a missing cuspid imbedded in the bone and the same tooth after being regulated to position where it was being held with platinum wire when this picture AB. was taken.

Fig. 13 shows what was probably the first skiagraph made in this country with a Radium compound, and probably the first in the world of the teeth. I made it May 6, 1900. A. shows the skiagraph of the teeth made with the radium compound, and B. shows the skiagraph of the same teeth made with the X-rays. You will notice marked difference in penetration of the two kinds of rays. This material was then called by Prof. Currie, Radioactive Compound.

DISCUSSION.

DR. LEAVITT E. CUSTER, Dayton, O.—*Mr. President:* Dr. Price considers his subject under four heads, the generator, the tube, the film, and the exposure. I agree with him in this, and I wish to emphasize that part of his paper, that for dental X-ray work, the induction coil gives us the very best results. But, I cannot agree with him when he says that the Wehnelt interrupter is the best means of operating the coil. I believe I have used nearly every one of the interrupters on the market, and I have devised a number of original ones myself, but after many trials, each of which was barren of perfect satisfaction so far as results were concerned, have finally returned to a porcelain diaphragm, which is perforated by a small hole, because I consider it the simplest, the most easily controlled, and the most efficient and serviceable of all the interrupters. All honor is due Wehnelt for his discovery of the electrolytic interrupter, and I do not wish to detract from that honor. It is this interrupter, I believe, that was modified by Caldwell and which is now known as the Caldwell interrupter. The underlying principle in both these interrupters is electrolysis, and also to a large extent, heat, but the manner in which this occurs is a very essential feature when energizing an induction coil. All electrolytic action is accompanied by the generation of heat, and when there is a sufficient concentration of the cur-

rent at the metallic point of the Wehnelt interrupter an insulating vapor surrounds the point and this causes the action to cease for the time being. On the other hand, a properly constructed Caldwell interrupter which has a diaphragm perforated by a small hole in which the interruptions take place, does not stop its action as this liquid heats. As a matter of fact, the hotter this solution becomes the more efficient is the interrupter.

I have given this form of interrupter considerable study and attention, and in this connection will present the same. It consists of a porcelain cup having an inside dimension of two inches by six inches. Near the bottom is a perforation made at an angle of forty-five degrees. The cup is poised in such a manner that it can be tilted to either one side or the other. When the cup is tilted to one side the perforation is horizontal, Fig. 1; when tilted on the other side the perforation assumes the perpendicular, Fig. 2. The underlying principle of this form of interrupter is the following:

The volume of the current is in direct proportion to the size of the opening in the cup, and the frequency of the interruptions is in proportion to the period of time that each bubble of gas is displaced and the current is again established. When the hole is in the horizontal position it takes more time for the displacement to occur than when the opening is in the perpendicular position; all variations may be found between these two extremes. The thickness of the wall of the cup and the depth of the solution also modify the frequency of the interruptions. A field rheostat in series with the primary is another and a very convenient method of controlling the current.

As to the tube, the same principle holds good in dental radiography that obtains in general work of this character. It differs in this respect, however, that, as a rule, we are required to differentiate between tooth pulp, bone, dentine and enamel. Fortunately, the bone of the alveolar process does not possess the density of other bones, and it is for this reason that we can often get the roots of the teeth to show with as much contrast as is seen ordinarily between flesh and bone. But, inasmuch as these contrasts must be secured in tissues of relatively high specific gravity, the tube must be comparative-

ly high; yet it has been my experience that a medium tube gives a more satisfactory picture than the high tube advised by Dr. Price. The same law under which the physician secures his best skiagraphs holds good in dental work; too high penetration destroys contrast.

The essayist did not touch upon what to my mind is one of the most important features in the selection of a tube for dental skiagraphy; and that is, that the tube should have a fixed vacuum. By that I mean a tube whose vacuum does not fluctuate from day to day. Such a tube is the Mueller, the Gundlach and the like. Tubes with regulating devices that are to be operated during the exposure are unsuited for this work for the reason that the exposure is made so quickly that the regulating device has not had time to act before the exposure is completed.

The target in the tube, as stated in the paper, should be heavy, and yet if we confine ourselves to dental work the exposure in these cases is so short that even the Mü target has not had time to become dangerously hot.

I am in full accord with the essayist that the exposures in dental skiagraphy should be made as quickly as possible. In this work the requirements are almost microscopic as compared with general skiagraphy, and these can be secured only by having perfect quiet and a quick exposure. Some years ago the problem appeared to be a matter of keeping the film dry for the long exposures necessary, but today it can be done so quickly that instead of hunting for a missing tooth we are now hunting for abnormalities of the pulp, dentine or cementum of the tooth. These results are obtained by a rapid strong exposure.

This brings us now to the consideration of the preparation of the film. With the elaborate and efficient appliances at our command today, I would criticise the method advocated in the paper. We wish to protect the film from light and moisture and I have found that if two pieces of film of the proper size are placed face to face and then in two separate coverings of waterproof paper, black, such as can be had of Seed & Co., that is all that is necessary. By placing the films

face to face the sensitive side is not exposed to any injury that might come from the paper covering, and, moreover, we have two films each of which may be developed in a different manner. A year ago, in this city, I exposed films with no other protection than a double covering of this black paper. After wiping off the moisture I packed them away and did not develop them until some five days afterward in my own laboratory in Dayton, O. These pictures all came out splendidly.

No criticism can be made as to the method of placing the film during the exposure. The aim should be to place the film parallel with the teeth, holding it firmly without bending it, and the tube being perpendicular to the film.

While dental skiagraphy may not be a subject of much interest to the majority of X-ray workers, yet I feel that I must say that the work done by Dr. Price is a credit to himself, to the association and to the dental profession.

A word as to the developer: I use hydrochinon and like it very much, indeed, although I must admit that it is somewhat slow in its action. It possesses one other fault or disadvantage to which I wish to call your attention. During the development of the plate or film there appears to form a coating on the negative and this should always be wiped off very carefully with a pledget of moist cotton as soon as the development has been completed. If this precaution is taken hydrochinon will give as good results as any other developer.

Dr. M. H. Cryer, Philadelphia: It gives me great pleasure to have the privilege of attending this meeting and I thank you for the courtesy of permitting me to make a few remarks. The paper is a very interesting one to me because my field of activity is the oral cavity. In this work the X-ray may be of great assistance in detecting the malformation of the osseous tissue, foreign substances within the jaws, and the position of impacted teeth. I have been very fortunate in having Drs. Pancoast,, Leonard and Kassabian to assist me along this line, but find one difficulty arising from the use of the X-ray in this work, i. e., it usually indicates the impacted tooth but does not give its definite relation to the adjacent tissue, nor does it give the precise direction of the roots so that the extraction would

be less difficult. From what I have seen of stereoscopic X-ray pictures, it is possible that by this work the tooth and its relation to the surrounding tissue can be more definitely portrayed, and acting upon this idea Dr. Kassabian is now engaged in perfecting such work.

By showing upon the screen some photographic slides taken from specimens of impacted teeth a better idea can be given of the difficulties of obtaining practical X-ray pictures from the living subject. The first slide is a picture of a tumor which was supposed to have been either an osteoma or an odontoma, but upon examination was found to be the latter.

The second case is one of an impacted canine. The apex of the tooth extended far up into the wall of the antrum. In cases of this kind it is important to know the exact position of the root, and whether it is straight or curved. This knowledge facilitates extraction and shortens the operation considerably.—In such cases the X-ray pictures, so far, have not given me the practical information desired.—In the next picture two impacted canine teeth are shown locked in the roof of the mouth. Here the X-ray would be of great assistance to the operator. In cases of impacted molars it is especially important to know the direction of the roots, whether they are directed forward or backward, inward or outward.

(The speaker showed a number of slides of similar conditions, interpolating only a very few remarks, as time was limited.)

Dr. Mihran K. Kassabian, Philadelphia: I am very sorry that I cannot demonstrate a stereoscopic picture of a dental case, as none are yet completed. I have taken some pictures of certain cases where the plates have been placed on the outside of the maxilla, the rays penetrating through the mouth which had been held open by a small block of wood placed between the opposing molar teeth. The direction of the rays is regulated according to the tooth that is to be skiagraphed. I have one slide showing an anklyosis of the inferior maxillary bone which was diagnosticated by the X-rays. If this slide is compared with another of a normal maxilla we may observe that the articulation of the inferior maxillary bone here appears

much lighter than is the case with the ankylosed where there is an irregular hazy appearance.

The second case is one of an unerupted bicuspid. The picture was taken in the same way as the first. I have also a picture of an unerupted third molar which occupies abnormally a position horizontal with the alveolar process. Of course, the time of exposure is a little longer in this method than where the film is placed into the mouth, but the method presents a decided advantage over the latter in that we can show the exact relation of all the teeth to each other. When examining by the intraoral method only a small film can be placed in the mouth and no relation of all the teeth can be demonstrated. This method is only applicable to the anterior teeth, incisors and cuspids. When you require a picture of molars and diseased conditions of maxillary bone the external method, by placing the plate outside and under maxillas, is preferable.

Dr. Chas. L. Leonard, Philadelphia: I, too, have a slide to show. The tooth in my case was located in very dense bone; in fact, it was ebonified. As it was impossible to put the plate on the inside of the mouth we put it next to the face with the light placed in such a position that the shadow of the tooth would be out of the line of the other teeth. Needless to say we had great difficulty in attempting to remove the tooth.

In the second slide you can see the reason for this. The roots of the tooth were curved so that the tooth had to be cut out with an excavator and the bone around it was so hard that it took sometime to remove it. The young man originally complained of a great deal of pain in the ear, but this all disappeared after extraction of the tooth; unfortunately, it has been followed by complete anasthesia of the region on that side of the face supplied by the dental nerve.

Dr. Henry H. Cook, Detroit, Mich.: I have two plates which I wish to show you. The first is a picture of a dental monstrosity, a central incisor double the width of a normal tooth. The second is a case of a nonerupted canine in a girl of nineteen. There is also a case of necrosis of the alveolar process with the formation a fistula in a woman aged thirty-two. The necrosis has been of long standing and all

attempts to treat the tooth through the fistulous opening proved a failure. A skiagraph was taken and the true condition revealed. The tooth was extracted and at the tip of the tooth was a small amount of roughening. Whether or not this was the cause of the irritation is the question.

I also rayed another case in which the dentist, in filling a tooth for the purpose of putting on a Logan crown, pushed a small piece of gutta percha through the root canal. Shortly afterward a fistulous opening formed and after trying for a year to cure the trouble a skiagraph was taken. In two of the pictures the foreign particle is seen with an immense shelling out of the aveolus. In another picture of the same case is a third particle which is the shadow of the elm tent used to dilate the fistulous opening. After dilating the opening the piece of gutta percha was washed out. After a few days the fistula closed and has remained healed.

The lower pictures on the same slide are those of a non-erupted lower tooth. I have done considerable of this work and have tried various methods.

In regard to the film mentioned by Dr. Price. I have found that if you make pressure sufficient to curve the surface of the film, you will crack it and make lines on its surface, which show after development. I have used the soft film and also the two in combination, putting several films in the same envelope, and I find that you can get as good results with ordinary Eastman film as with the other. Of course, it is only natural that each operator will select his own technique and use only such films as are most suited to his methods, and he will get better results, perhaps, than other men will who may follow his dicta.

I have a number of small black envelopes of single thickness. I cut the film for the envelope and I can put in either one film or several, as I may wish. For protection of the envelope I use the ordinary paraffin paper. It is cheap and easily obtained and two or three wrappings of paraffin paper furnish absolute protection for almost any exposure. When you are through unwrap the black envelope, throw away the piece of paraffin paper and you have no moisture. I think it is a much

better plan than that of Dr. Custer, although it may not work as well in the hands of others as does the rubber. I am very well satisfied with it and I get excellent results with the ordinary Eastman film.

DR. CUSTER: I fear that I have been misunderstood. I take two pieces of film and place them sensitive side to sensitive side. Then wrap them up in black paper so that the films never come in contact with the wrapper.

DR. PRICE (closing the discussion): I have taken a piece of this film as you see and bent it double, punched it and rolled it, but it has not cracked or creased; nor have I ever seen one that could be cracked or creased.

Dr. Cryer brought up a very important point with reference to locating an impacted third molar. It is really very simple to do that. I always take two pictures of these cases, so as to get two views, at slightly different angles. Sometimes I place these two plates in the stereoscope and that gives me the exact location of the tooth and also the direction of its roots. I am very sorry that a number of slides that I expected, have not arrived. They show such cases as Dr. Cryer exhibited and they would have been of special interest to Dr. Cryer because they would have illustrated better than I can tell it, what he is after.

THE THERAPEUTIC EFFECTS OF THE X-RAYS, AS SHOWN FROM THE RESULTS OF TREATMENT OF NEARLY ONE HUNDRED CASES.

BY DR. HENRY K. PANCOAST, M. D.

Of Philadelphia, Pa.

The following report is based upon the results of treatment of nearly one hundred patients at the Hospital of the University of Pennsylvania during the past eighteen months by Dr. Harvey Bartle, Mr. Henry C. Welker and myself. It does not include a few cases of skin diseases, as I prefer to omit the subject of diseases of the skin, not being a dermatologist. A great surgeon has been quoted as saying that there were two kinds of skin diseases in his opinion—those that zinc oxide would cure and those that zinc oxide would not cure—and our knowledge of the subject is but little better. It seems rational that X-ray specialists, like surgeons or nose and throat men, cannot be skin specialists as well, when treating cutaneous diseases with the X-ray as a therapeutic agent any more than when using any other means of treatment, and I do not feel that we should deal with skin lesions unless thoroughly familiar with that branch of medicine, for we are using an agent that may do great harm, and we may not know how far to go with it, or whether a case is improving or doing badly. Let the dermatologist use the X-ray himself as a part of his therapeutic armamentarium.

We will here consider the subject of tumors, including sarcoma, carcinoma, epithelioma, lupus and keloid. No doubt very many of the members of this society are extremely enthusiastic over the X-ray treatment of cancers, sarcomas and other growths, and it is to be hoped that we will hear from them in the discussion of this report. When I first took up X-ray work, I felt that it was to handle a force that might possibly revolutionize the whole practice of medicine; that it was a "cure-all" for all tumors, especially the malignant ones; and that it would nearly always yield the results desired and expected. Such ideas were formed from reading the reports made in various medical jour-

nals and newspapers. How many of us realize that it is mainly the cases cured or progressing favorably that are reported, and not often the failures? What a volume the latter would fill! I must confess that up to the present time I have been very much disappointed in the results obtained from the X-ray in the treatment of cancer and sarcoma.

In the treatment of the important growths, namely, sarcoma, epithelioma, and carcinoma, I feel that the percentage of cures to be obtained at the present time is not over ten, taking all the cases into consideration that come to us for treatment, the hopeful and the hopeless. This is, no doubt, a radical statement in the minds of many, but there are certain well-defined reasons for such results in a large charitable institution.

In the first place, most of the cases included in this report, were treated in an institution as out-patients. Such individuals do not come in for their treatments regularly. If the weather is bad or they do not feel disposed to go out, they stay away, and this, of course, interferes very much with the satisfactory progress of the treatment.

Secondly, out-patients usually all come at some particular time of the day in a body. Your time is limited, you are hurried in your work, and you do not have sufficient opportunity to examine each case as you would like to, and as you should. It is not like having cases come to your office, where you can question and examine each one carefully.

Thirdly, office patients are paying for what they receive, are more interested in their own well-being, and therefore come regularly and as often as is required for treatment, and the results are better beyond a doubt than in the case of hospital out-patients. No one will doubt that the application of the X-rays is not the only part of the treatment of our patients suffering from malignant tumors. To obtain the best results, each case should be made a careful study in itself, both as to the local condition and the patient's general health.

Fourthly, it must be borne in mind in this connection that the X-ray room or laboratory in any large institution is in a manner looked upon as the "dumping ground" for material that cannot be successfully treated in the other departments. For instance, when nothing more can be done with the knife, the case

is turned over to the X-ray man to see what he can do. This is perfectly justifiable, for our grandest hope is to do something for just such hopeless cases, when the only chance lies in the Rœntgen ray treatment, and with these poor sufferers we have the incentive offered to put forth our best efforts in the improvement of our technique. A high percentage of cures often means that hopeless cases have been refused treatment, and 10 per cent. of malignant cases cured in a large hospital at the present time, I feel to be a favorable outcome.

There is no doubt that the X-ray treatment has given some marvelous results, such as will be obtained from no other form of treatment, and it is probable that improvements in technique and apparatus, and increased knowledge of tissue changes under its influence will in the future bring about much better results than we obtain at the present time. I am not discouraged by our failures to affect cures in more cases, as I feel that we are apt to be over-enthusiastic and to expect too much of a practically new and not thoroughly understood therapeutic agent.

The Rœntgen ray will probably never supplant the use of the knife in the removal of growths in dangerous areas. It is almost criminal for anyone to *advise* X-ray treatment in such cases as carcinoma of the breast or epithelioma of the lower lip. This treatment takes too long a time, and in the meanwhile the patient is liable to metastasis to areas beyond our reach. This has been only too frequently seen in such cases in which the patient has refused the knife, and we have been obliged to apply the rays against our better judgment. It is in these cases that we find a loophole for quackery. I feel that in a very large majority of cases of cancer in which the X-ray is advisable in treatment, the application should be preceded by the removal of as much of the growth as possible by the knife or curette. Cosmetic results on the face form, of course, one of the strong exceptions to this rule. One of my main objections to X-ray treatment from the therapeutic standpoint is the very great inducement it gives to quackery, and I see no reason for giving any mercy to the "quack" using this agent for what should be legitimate medical purposes only. I am very much opposed to the use of caustics in conjunction with the X-ray treatment, as they are altogether destructive in effect and interfere with healing, and cannot compare in effi-

ciency or safety with the knife or curette. It seems hard to conceive how any case that cannot be aided by the X-ray can be helped by the addition of caustic applications.

I feel certain, as I think many of our members do, that in some cases the X-ray may do more harm than good, but at the present time we cannot distinguish such cases from the rest. It may be that in certain instances death has been brought about sooner than it would have otherwise occurred. For this, we cannot be held in any way accountable, and if made a medico-legal question, it should be our duty to make it a point of no import. The following cases are reported as examples of some in which X-ray treatment is of little or no value. Let it be acknowledged that this agent is of very little value in curing such cases, and even if death be hastened thereby, we still know that the patient would die under any circumstances, and we have put forth our best efforts at a cure, that we have a good chance of relieving pain, and that we are doing the best we can do.

Case 1. Multiple epithelioma involving the upper lip, nose and forehead. She was admitted to the hospital June 22, 1902. The first picture (Fig. 1) was taken two weeks afterward, and shows the condition very well. The second picture (Fig. 2) was taken about nine weeks following admission, after 32 treatments, and shows a tremendous spread of the growth over the upper lip and complete destruction of the tip of the nose. After 14 more treatments and currettement, the lip was almost completely destroyed, and the patient presented a horrible appearance, of which we have no photograph. She wished then to return home and die, rather than run the risk of further deformity away from her family. It still seems probable that after complete destruction of this area we could obtain healing, but with entire loss of the upper lip and lower half of the nose. We were able to bring about almost complete healing in the areas on the forehead and upper part of the nose. This patient, barring some intervals, was treated from three to six times a week. We might conclude that the X-rays were, *per se*, powerless to check the spread of the growth, or that the technique was faulty, but there was certainly no chance of obtaining a cosmetic result with restoration of tissue. There was surely some stimulation offered toward more rapid progress of the growth. The treatment gave the patient no re-

lief from pain, and, in fact, increased it from the start. After each application there was an almost immediate exacerbation of pain, which was still worse on the day following.

Case 2. Large epithelioma of the left temporal region. This patient began treatment July 7, 1903, and since then has had 73 applications. There has not been any improvement in his condition, and the growth is slowly but surely spreading. The photographs (Figs. 3-4-5) were taken July 16th, September 5th and November 29th respectively. Now that there are so many reports about the use of radium in the treatment of cancer and lupus, we have given it a trial in his case for the past week or ten days. In this particular case, five applications of radium have been substituted in the place of X-rays and lasting 10 to 15 minutes each. Our specimen is the bromide salt of 7,000 radio-activity. This patient was informed of the fact that radium was being used, of the marvelous reports of cures made by it, and of its cost. He imagines he is improving, although such is really not the case. I am extremely skeptical in regard to the favorable results obtained by the therapeutic use of radium and am sure that many of the reported improvements are purely psychic in nature, as it was in this case. Some recent articles written upon the subject in this country, have bordered on the ridiculous. Had our patient not been informed as to the nature of the substance being used, he would not have noticed any improvement in his condition.

Case 3. Large metastatic epitheliomatous mass on the back of the neck and the sub-maxillary region. This patient presents a horrible appearance and is one in which the X-ray could do no good whatever. He died after four treatments. This growth was secondary to a small epithelioma of the lower lip removed about two years before by cancer plasters, and the case serves well to illustrate the danger of treating epithelioma of this region by such slow methods as the X-ray. The photograph is here shown. (Fig. 6.)

Case 4. A recurrent epithelioma of the superior maxilla. This is the third recurrence following operation upon the primary growth, and this tumor has extended into the orbital cavity with protrusion of the eye, into the frontal sinuses, and probably into the cranial cavity. When first seen there was considerable

ulceration of the tumor mass below the eye. This ulceration healed very nicely under treatment with the ray, but the upper part of the tumor continued to grow steadily and the patient died. About 60 applications in all were given. There was at first a decided relief from pain, but later on, morphine was required. A photograph (Fig. 7) was taken not long before the termination of the treatment.

Case 5. A metastatic epitheliomatous growth of the glands of the left side of the neck following a primary lesion on the tongue, for which half of that organ was removed nearly a year ago. The patient began treatment September 8, 1903, and until November 3, received 44 applications of the X-rays of 5 to 10 minutes' duration each, outside upon the neck, and seven treatments inside the month (to prevent local recurrence). About this latter date a slight burn appeared over this area in the neck. The length of the treatments was then shortened to three or four minutes, fifteen such exposures being made up to November 20th. Then the burn reappeared and was of the second degree, but soon yielded to zinc ointment. After seven more sittings, treatment by radium was begun over the area in the neck, and up to to-day eight applications of ten minutes each have been made, the X-ray having been stopped. The burn is entirely healed. The photograph (Fig. 8) was taken when the radium treatment was started. The reason for this change was the fact that the X-ray seemed to have little or no power to control the growth. Whatever pain the patient had before has been relieved, however, and much of the apparent stiffness in the muscles of the neck and very likely the rapidity of growth in the glands has been retarded to some extent, and life prolonged, but a cure does not seem in any way possible. The burn in this case, like all others we have had so far during the treatment of cases, healed rapidly. It does not seem necessary that burns should cause any anxiety as long as they are carefully watched and cared for. But only those physicians or surgeons familiar with X-ray burns and their treatment should be the ones to look after these peculiar lesions.

Case 6. A patient suffering from a large protruding recurrent carcinoma of the rectum following a Kraske operation for removal of the primary growth. The case was a hopeless

one, and treatment was given with the hope that it might possibly prove to be one of those rare cases that once in a while startle us by being reported as cured and given world-wide publicity. Then, too, the comfort of the patient was to be taken into consideration. The first application was made July 7, 1903, and until October 18, twenty-one treatments of about ten minutes' duration were given anteriorly through the abdominal wall and twenty posteriorly over the anal and sacral regions. He was not in a condition to be treated again until November 20th and from then until the 29th four more applications were made, and then radium was tried, it having been used five times so far, ten minutes each time. The photograph (Fig. 9) was taken November 23d of the anal region, showing the protruding mass.

Case 7. This patient is still another in whom no results have been obtained by X-ray treatment and none are seriously looked for. After an operation in January, 1903, for removal of the left breast for carcinoma, she was sent to us for treatment June 25th for a recurrence in the supra and infra-clavicular and axillary regions, with marked œdema of the arm. Until December 3d 48 applications were made of about 10 minutes each. Such treatment is by all means too mild, but the patient is the person to blame for this as she was very irregular in her attendance. The growth has been steadily progressing. The photograph (Fig. 10) shows the condition at this time.

Case 8. No case can be mentioned as a more horrible example of the ravages of carcinoma nor of the futility of the X-ray to accomplish any result than does this one. The patient had previously had the right breast and usual structures removed for carcinoma, and was referred June 6, 1903, for X-ray treatment of metastatic lesions in the lymphatic glands and channels in all directions, and also in the opposite breast. This patient's welfare was most faithfully observed and eighty-two treatments were given until September 18, this being almost daily. Our greatest hope was, of course, to cure such a case, and particularly as the patient gave us every help she could. But who in his inner conscience could expect such a case to get well? There is no doubt but that we held the disease somewhat in check, relieved much of the pain, for a long time rendered opiates unnecessary, and really prolonged life. This latter result we know to have been

well worth our efforts. In order to attend to important family matters the patient returned home, promising faithfully to reappear in ten days. As was to be expected, she came back in one month and gave every appearance of a good example of the dangers resulting from stopping X-ray treatment before it is actually and absolutely cured. This applies to *any* condition for which the X-rays are being used in treatment. During the first two weeks of her absence the patient remained in about the same condition as when she left, but from that time until her return the growths took a fresh start and she said she "could fairly see them grow." When she again presented herself for treatment everything was worse in appearance than ever, and there were also evident signs of mediastinal metastasis. This patient survived long enough to receive 14 more applications and then died. We have the satisfaction of having given her more relief and happiness in the last few weeks of her life than even morphine could have yielded.

The foregoing cases are but a few of the many examples of the class of patients they are intended to represent and serve to bring out the points of importance. There is no argument to oppose these facts, for no man of any experience has any other results to offer. Literature abounds in brilliant results following X-ray treatment, but are these reports of any real importance to mankind in general, and do they accomplish much more than to bring the writer into prominence? We want facts!

Medical literature is crowded with reports in which patients have been exposed to the X-rays with more or less benefit, or none whatever, and have discontinued treatment after a certain length of time, and such experiences have shown that the patients are made unfortunates by having their lives shortened, as the disease invariably takes on a more rapid growth.

The question has frequently arisen as to recurrence following an apparent cure by X-ray treatment. There is no longer any doubt as to the possibility of recurrence and the X-ray has the advantage over the knife only in being able to penetrate deeper and with less disfigurement and in prolonging the treatment in its ability to prevent recurrence. Having obtained a cure according to subjective and objective signs, there are certain cases in which we can practically say that there really is never an abso-

lute removal of the growth or its source. Carcinoma of the cervix uteri is one of the most decided examples of this class of cases. The next three reports are of patients in whom recurrence has followed Rœntgen ray applications.

Case 9. Carcinoma of the cervix uteri. Thirty X-ray applications followed a curettement and the patient was declared cured, but was advised to return for treatment once a week for a while in order to prevent recurrence. The word "cure" seems to satisfy some minds that give no thought to the future, and this case comes within such a class of individuals. She failed to carry out our advice and in six months returned with a recurrence that was just making itself manifest.

Case 10. Epithelioma of the right temporal region that began about two years previous to the time the patient was sent to us. The growth had been treated by "plasters" and healed, but had afterwards made its appearance in a contiguous area and was commencing to break down the area already healed, and was invading both eyelids, causing almost a complete closure of the palpebral fissure. Treatment was begun October 27, 1902, and up to December 17th, twenty-two applications of ten to fifteen minutes each were made. The eyelids had healed, but a troublesome œdema of the conjunctiva developed, necessitating the shielding of the orbital region in the future, except for an occasional treatment. In this case as in others treated for growths involving the eyelids, it was found that when an œdema of either the conjunctiva or lids had once developed, it was a most difficult condition with which to deal and even one additional application now and then would serve to make it worse. From December 17th to February 3d, 1903, only eleven treatments were given, and the œdema was no better and the skin was slightly burned around the margins of the diseased area. The ulcer was lightly curetted under cocaine anæsthesia. The area was thoroughly curetted February 26th under ether, no treatments having been given in the interval. A thick slough was removed and the bone exposed. It may be well to mention here that in several cases in which epitheliomata have been treated in which the growth extended down to bone, great difficulty was experienced, not only in being able to tell when to let up in the applications in order to allow the healing process to begin, but also in promoting

the process of granulation and obtaining a new growth of healthy connective tissue and skin. The ulcerated area was healing nicely in our case when on March 19th he had to be admitted to the eye service of the hospital on account of beginning ophthalmitis. It was decided best not to perform an enucleation as the patient was found to have a chronic fibroid phthisis, involving both lungs. The eye got well except for the corneal opacities and xerotic keratitis still remaining, and he was soon discharged and never reappeared until May 29th when he presented a large fungating recurrent growth of the right temple behind the old ulcer, which was not yet quite healed but not much involved in the new growth. The recurrent area was the one that had been once before healed by plasters previous to his appearance before us, and which was then beginning to show some few spots of degeneration, but these were quickly cured. The patient was admitted and the new growth was curetted. A poor photograph (Fig. 11) is shown, which indicates his appearance then. He was treated 34 times, five minutes each time, from June 4th until August 30th, when he was discharged to become an out-patient, as a hospital was thought to be a poor place for such a patient through the summer. The ulcer remaining about the size of a half dollar showed no macroscopic evidences of malignancy, though the surrounding new skin was thin and of poor vitality, as there was very little tissue covering the underlying bone and a poor blood supply. A photograph taken July 16th (Fig. 12) shows the improvement at that time. Xerotic keratitis and conjunctivitis were still present. X-ray treatment was to be continued as a preventive of recurrence, and from October 9th until December 3d, 20 applications were made, the patient having been admitted for an interval during this time.*

Case 11. Large epithelioma on the right side of the thoracic wall, 6½ inches wide laterally and 4½ inches wide from the lower border of the great pectoral muscle to about the costal margin below, and extending slightly to the left of the sternum. This growth was of about eight years' duration. X-ray treatment was

*Since this paper was prepared, and a few weeks later than the convention, this patient developed an abscess of the orbit and on operation a considerable area of epitheliamatous metastasis was discovered in the orbital cavity, it having been entirely hidden from view previously.

begun April 26, 1902, and during that year until November 21st, 77 applications were made, varying from five to ten minutes each. At that time the patient was unable to continue his visits on account of general weakness, and a very marked contraction of the thorax and abdomen in front, causing a very prominent dorsal kyphosis and greatly deforming him. The ulcer had diminished to almost half the original size, but continually discharged portions of costal cartilage uncovered by the disappearing malignant base and a greater part of the edge remained undermined and ragged, except at the lower and inner area. Exercise seemed to have no effect in relieving the contraction of the body.

The patient returned May 20th, 1903, feeling and looking much better than when last seen six months previously. The contraction had improved to a considerable extent and the ulcer was about 3½ inches in diameter, and had a smooth and healthy, though rather indolent, base, and the edges, except for a small area below and to the left and above, under the great pectoral muscle's edge, were likewise healthy and not undermined. Here we see marked improvement by the patient keeping away from the X-rays and dressing the area himself. But, just below the ulcer in the abdominal wall, there was seen a large mass, the size of an adult fist, and to be recognized as a recurrence or extension. From May 20th to December 3d, 52 applications were made, and this new growth has practically disappeared, but the ulcer, though smaller, shows but little improvement compared to what was expected.

But this is enough of unpleasant things, and now looking upon the brighter side of life, something will be said about cases that have been improved or cured.

Case 12. Recurrent epithelioma of the dorsum of the right hand. The growth has twice recurred after operation, and was curetted in August, 1903, at the University Hospital, as a preliminary to the X-ray treatment. He was referred to the department August 22d, and up to December 4th received 31 applications averaging about five minutes each. The photograph (Fig. 13) was taken September 5th after seven treatments. At the present time (December 10) there remains a healthy ulcer about the size of a five-cent piece. The whole hand is receiving the rays frequently as a preventive measure.

Case 13. Multiple epitheliomatous ulcers of the frontal and temporal regions. The first photograph (Fig. 14) shows the condition when treatment was begun July 21, 1903. The second picture (Fig. 15) taken September 5th, indicates perhaps some improvement, but the area posterior to the external canthus has broken down more. The third plate (Fig. 16) gives proof of considerable improvement. Up to October 24th, 34 treatments were given, each averaging five to eight minutes, and then the patient ceased to make his appearance any longer.

Case 14. Epithelioma of the tip of the nose, which made its appearance about three years before treatment was begun by the X-ray. The skin dispensaries of two hospitals failed to bring about a cure, but this was very likely due to the irregularity of her visits. X-ray treatment was started February 20th, 1903, and exposures of five to eight minutes were made two to three times a week until May 24th. The photograph (Fig. 17) shows the condition at that time. Future records were lost, but the last visit was made June 29th, at which time the growth had entirely disappeared. The patient was advised to return once a week thereafter as a preventive of recurrence, but she has never been seen since. No doubt we will see her again, or some other hospital will have her on its records, as there will no doubt be a recurrence through failure to carry out the after-treatment.

Case 15. Rodent ulcer of the nose. The area was first curetted and X-ray treatment was started July 28, 1903. The picture (Fig. 18) shows the appearance September 10th, after 18 applications. In all, 32 treatments, averaging six minutes each, were given, and the patient was discharged September 17th with the area entirely healed. The patient returned to his home and has been having occasional applications to prevent recurrence, and expects to return later to undergo a plastic operation for restoration of the appearance of the nose.

Case 16. Epithelioma of the left cheek and temple (Fig. 21). Came for treatment November 24, 1903. After three applications of ten minutes, the fungating area on the cheek was curetted last week and X-ray treatment has been resumed. It is too early to expect improvement as yet, though it is to be looked for.*

*Since cured after about 20 applications.

The foregoing cases serve as examples of the results to be obtained in the treatment of superficial cancers by means of the Rœntgen rays. The next superficial growth to be mentioned is lupus. There may be some doubt as to whether these rays or those of the violet end of the spectrum are the more effective in dealing with this lesion. Finsen himself has given out the decisive statement that a powerful arc light (with rock crystal lenses) is the only source of ultra violet rays to yield good results, and it is very doubtful whether or not there are more than a very few devices, if any at all, in this country capable of doing the work as Finsen directed it should be done. There are hundreds, however, who are able to generate X-rays as powerful and efficient as can be done anywhere in the world, and should they prove as effective as the ultra violet rays, they have many advantages over the latter. But there is much doubt as to whether they are as destructive to the lesions of lupus as the Finsen light properly used, and there are to be considered such dangers as burns, risks to the eyes, destroying the pigment of the skin and many others.

Case 17. Male, colored, 19 years. Lupus of three years' standing, involving each side of the face, each upper and lower eyelid and the nose. His first appearance at the hospital was made at the eye dispensary on account of a double ectropion. The nose was about twice the natural size and covered by a papillary growth. The eyelids were very much swollen. X-ray treatment was begun February 15, 1903, and directed to all parts affected, but great care was taken to protect the eyes as much as possible. Up to December 1st, 151 applications were made of three to ten minutes' duration each. The photograph (Fig. 22), taken July 16, shows the patient's appearance when about 50 per cent. improvement had taken place. It will be noted that the black pigment of the skin has in many places been destroyed, but this has occurred only in areas where new skin has formed. At the present time the nose is almost entirely healed, though white, the ectropion is much less marked and the whole appearance of the face is much better. Instead of being an outcast, the man can now mingle with humanity, and we have the greatest hopes of curing him. We look upon him as our prize patient. There is grave doubt as to whether there will be a deposition of pig-

ment in the new skin, but it is to be expected that there will be some effort at least to restore this loss, and there really does seem to be some slight change to a darker hue already.

Case 18. Female, white, 42 years of age. Lupus of the nose of about three years' duration. The first picture (Fig. 19) shows the condition when treatment was started November 11, 1903, and the next one (Fig. 20) represents her appearance at present after 12 applications of about ten minutes each.*

In dealing with keloids and hypertrophied scars, we have to consider growths made up for the most part of fully organized tissue, and not of cells of less vitality than normal ones. Therefore the process of removal must be largely one of destruction. The treatment is of necessity a very long one. In all of our cases the treatment has been pushed to the point of a slight burn, and in all of them, being negroes, the pigment has been more or less destroyed in the skin.

Case 19. Female, colored, aged about 21. Keloid of the left auricle following piercing of the ear. Treatment was begun November 3, 1902, and by May 11, 1903, after about 65 exposures of ten to fifteen minutes each, the patient was declared cured, though one application was made every week for a time, as a preventive measure. Thiosinamin was given throughout the course of treatment.

Case 20. Female, colored, age 39 years. Kleoid of the right auricle and side of the neck and face and back of the ear following an operation for suppurative cervical arenitis (post-typhoidal) at the age of 16 years. The growth was removed 12 years ago, but recurred in two months. The first exposure was made August 21, 1902, at which time the first picture was taken (Fig. 23). Thiosinamin was given for a while, but could not be borne by the stomach. The growth was extremely painful and tender, but these symptoms have disappeared except to be present during some peculiar phenomena that will be mentioned later. For a long time, also, we were unable to account for the pain in the neck below the growth and radiating down the arm, but examination showed this to be due to double cervical ribs, the one on this side being more prominent. Nineteen exposures of ten

*This patient has since been discharged cured, after receiving about 25 treatments.

to fifteen minutes each were made up to October 13th, when the first of a series of peculiar attacks made its appearance. The growth became very painful and exquisitely tender, and then gave all the other local signs of inflammation followed by suppuration, and also the usual constitutional symptoms of a mild suppurative process with absorption of products were present. A week following the last exposure a large abscess was opened, the cavity seeming to extend beneath the whole of that part of the growth on the side of the face and neck. Thick greenish and foul pus was discharged. The abscess healed in a few days, almost without drainage, the infection not appearing to be virulent. The destruction of tissue appeared to have been in the healthy normal structures under the tumor or in the adjacent portion of the growth itself. After healing, there was a noticeable subsidence in the size of the neoplasm. Treatment was continued from November 2d until November 23d, 12 exposures of ten to fifteen minutes each being given, and then there was an interval on account of burning of the skin. After nine more exposures during the remainder of the year, the patient was admitted to the hospital January 4, 1903, on account of œdema of the arm resulting from pressure of the cervical rib on the subclavian vessels. After seven more exposures of fifteen minutes, treatment was again stopped January 20th on account of X-ray dermatitis, and February 11th another abscess under the growth was opened and the same character of pus evacuated. There were present the same constitutional symptoms as previously noted. Healing was complete in a short time with again a subsidence in the size of the mass, and application started February 25th. From then until September 4th, 50 exposures were made varying from eight to twenty minutes each. The second photograph (Fig. 24) was taken July 16th. September 7th the growth behind the ear was removed. This was thought to be a fibro-lipoma, but microscopic examination shows it to be a keloidal tumor, and we have learned that it is common in the Southern states to find this shaped growths behind the ears of negroes with keloids in this region. From September 13th to October 31st, 19 exposures were made, and then once more there were local and constitutional symptoms of suppuration under the tumor. We stopped just in time, and even though there was softening and suppura-

tion, the area did not have to be opened. Again, there was a decrease in size. Five additional treatments have been given, and now the growth is almost reduced to the level of the surrounding normal parts. For a while the scar of the operation was not exposed, but it showed very early signs of hypertrophy, and treatment was directed to it, but as yet without stopping the increase in size. This is an important point as it has been thought possible to remove a keloid by the knife and use the X-ray in preventing a recurrence. The photograph shows the destruction in certain areas of the skin pigment.

Case 21. Female, mulatto, age 27 years. Keloid of the helix and lobule of each ear following "piercing." From February 14, 1903, to the present time, 80 applications have been given to each side, varying from six to ten minutes at each exposure. There has been some improvement, but it is not so marked, as we have not pushed the treatment and the patient has been irregular in attendance. The photographs, one of each side (Figs. 25-26) were taken May 24th, and show mainly the destruction of pigment even in this mulatto.

Case 22. Male, colored, age unknown. Multiple keloids, backs of both hands and wrists, both sides of necks, etc. But a few exposures were made and the case is mentioned and the photograph of each side (Figs. 27-28) shown simply to show that there has been a destruction of black skin pigment on account of another variety of burn than X-ray burn. This patient was injured in a gunpowder explosion and the growths followed.

As to sarcoma, we have had but little experience in the treatment of this form of malignant growths, and although in some ways the results have been satisfactory, we are pretty well convinced that it does not respond well to the X-rays.

Case 23. Male, white, 19 years of age. Large recurrent sarcoma of the anterior abdominal wall, as shown in the photograph (Fig. 29). There was a large nodular mass about the size of an adult fist, ulcerated and fungated on top and bleeding profusely and readily. X-ray treatment was started January 14, 1903, four months after this recurrent growth was first noticed. Thirty-eight exposures of thirty minutes each were made daily except Sunday, with the tube but two or three inches from the skin. There was really no severe burn until the end of these six

weeks, and at that time, March 9th, the growth had decreased to at least half its original size. The patient was then obliged to suffer quarantine in the hospital ward on account of smallpox breaking out there, and when his isolation was over in two weeks, he preferred to return home, as the sarcoma had begun to grow rapidly again. This case is of interest on account of the very severe and prolonged treatment given before the appearance of any very bad X-ray dermatitis. The most rapidly appearing burns we have ever noticed was one that made its appearance in less than 24 hours after a single twenty-minute exposure.

Case 24. Female, white, about 55 years of age. Sarcoma of the anterior surface of sacrum. It was inoperable, and X-ray treatment was given through the vagina by means of a German silver Ferguson speculum. The rays were also directed through the body from the back and front. From January 24, 1903, to April 5, 30 vaginal applications of fifteen minutes each were made and 21 exposures through the body. There was very great improvement, but the patient ceased coming.

This covers all the ground intended for this report with the exception of carcinoma of the uterus, but some mention has already been made of that subject. Leg ulcers, Hodgkin's disease and Paget's disease and several other conditions are also included in our list of cases, but time will not allow our taking up these subjects. We have tried to give you a few general ideas about the cases as we have found them at the University of Pennsylvania Hospital, and we hope that we shall be able to hear of the experiences of some of our members from different sections of the country, as we are all here to learn something.

DISCUSSION.

DR. CLARENCE E. SKINNER, New Haven, Conn.: I think the experiences that Dr. Pancoast has detailed are about parallel with those of all of us. My own personal experience has differed somewhat from his in one or two points, but in the main Dr. Pancoast's conclusions are clinically confirmable.

With regard to the treating of lupus or any other malignant process which involves more than one kind of tissue, I think that the procedure of election is primary operation to be followed by

X-ray exposures. As to cancers of the lip, I have treated three cases; two of them got well, but the third grew steadily worse. Cases of malignant disease of the ear which involved the cartilage and the surrounding skin, I have never seen get well under X-ray therapy alone, although others claim the reverse, and in my opinion that is an argument in favor of using the X-ray alone, if for any reason we cannot operate. Many of these cases are too old to be operated upon; some refuse operation, and in still others there are some circumstances that make an operation inadvisable; therefore, as it gives us some hope of cure or benefit in some cases, it is entitled to a respectful mention in this connection.

With reference to malignant processes involving bony tissue, such as cancer of the superior maxilla, I would say that I have never seen such a case cured by the X-ray, and I know of but one man who claims to have cured such a case with this agent. Of course, the X-ray will usually improve these cases temporarily, but, so far as I know, they nearly always recur and sometimes seem to grow with increased rapidity thereafter. The ray will reduce the pain, however, and make the patient more comfortable.

Sarcomata at first seemed to offer a better prognosis than did carcinomata, but, I think, we all have come to the conclusion that sarcomata do not respohd to treatment with the ray as well as epitheliomata. I have had one very remarkable case of sarcoma, however, which has not yet been published, and which I would like to mention. It occurred in a school teacher who had had her uterus and adnexa removed some four or five years ago for what was supposed to be a fibroid. The clinical diagnosis was looked upon as so firmly established that it was not considered necessary to make a microscopical examination. About eighteen months afterward the lady noticed a lump in her abdominal wall. She immediately consulted Dr. M. H. Richardson, of Boston, and he pronounced it a malignant tumor and inoperable. He sent the lady to Dr. Coley, of New York, for treatment with Coley's toxins. She received this treatment for about nine months. During the first three months the growth grew considerably smaller; then it remained stationary, and finally it again took on growth and increased very rapidly in size. A piece

of the tumor was removed for microscopical examination and found to be a fibroid sarcoma.

A year ago last January she came to me for X-ray treatment. At that time the tumor was very large and of a stony hardness. It measured about ten inches in its lateral diameter and eight inches in the vertical. Dr. Coley informed me that it measured about six inches antero-posteriorly when he removed the section for microscopical examination. I began to treat her with the X-ray over the growth, using the static machine and a high penetration tube. In about three weeks her general condition was very much improved, and the unpleasant sensation in the abdomen, of which she had complained very bitterly, grew less. On the anterior surface of the tumor there formed during this time an area of softening about as large as an ordinary sized saucer. From that time on I did not notice much change in the general appearance of the tumor, but her general condition continued to improve steadily.

During all this time she had had several attacks of toxæmia, and about June she had such a severe attack that I sent her home for five or six weeks to rest up. When she returned, the tumor had decreased in size about twenty-five per cent., as nearly as I could judge, and it also had softened a great deal. From that time on until about three or four months ago, I treated her on an average of about twice a week for the first six months, and then about once every two weeks. She resumed her duties as a teacher a year ago last September and has been teaching ever since. The tumor has steadily decreased in size, and it is now about as large as the palm of my hand and apparently about as thick. It is located in the lower right hand quadrant of the abdominal wall. Shc no longer complains of unpleasant feelings, and weighs 140 pounds, a gain of 30 pounds over what she weighed when she first came to me.

I have not given her any treatments for about three months because about two months ago she developed a little area of necrosis. I saw her about two weeks ago and the necrotic spot was about the size of half a dollar. This little area is dark red in color, but it has never shown any tendency to become gangrenous. There is no scab on it; it is simply a raw ulcerating surface. I shall not treat her again until the ulcer has healed, as my experi-

ence has taught me to let these things alone, as far as X-rays are concerned, until they are healed.

This is, of course, an extreme case, but it demonstrates that the X-ray is sometimes capable of producing magical effects in the way of restoring otherwise absolutely hopeless cases to lives of usefulness and comfort. I shall report the case in full later.

DR. G. C. JOHNSTON, Pittsburg. Some dermatologist divided skin diseases into three classes: Those that sulphur would cure; those that mercury would cure, and those that the devil himself could not cure. I divide diseases into three classes, as follows: Those that I can cure with X-ray; those that someone else can cure, and those that nobody can cure.

I have been very much pleased with the doctor's paper. He certainly has a wealth of clinical material. But there is one thing that I do not like about his paper or his attitude toward the X-ray treatment. I think that he is a little too charitable and is inclined to say that many of these cases are not suitable to the X-ray treatment, and that they do not do well under it. One reason for that is, as he says, that he has too much material at his command, so that he does not get time to study every case thoroughly and in all its phases. He treats the cancer of the patient instead of treating the patient for cancer. That is the trouble I have had in much of my work. As soon as I get more work than I can conveniently handle, I do not have time to study each case thoroughly.

I believe that in certain cases the X-ray cannot be expected to cure, but in a large percentage of the cases a cure will be effected if we work hard enough, and if we will try to find out whether we can cure that case. I have had cases die under treatment; in fact, one case died after only one exposure, and another died before I could make an exposure. There always is a good reason for our failures. I am not speaking of cases you expect to cure, but in cases where you say you can cure; the case goes along for a while but it does not do well. Perhaps this is just the case you want to cure and that case will not get well. It is possible that sometime in the future we may know why these cases do not get well. I do not believe that the ray is at fault, but I do believe that we have not yet learned all there is to know

about the ray. We did not know as much about it a few years ago as we do now, and there is much more to learn yet.

As Dr. Pancoast continues with his work he will become more enthusiastic. I do not know any man whose work is successful who is not an enthusiast. Enthusiasm is the only thing that will make you work. And the large majority of men who are successful in this work are enthusiasts. I wish Dr. Pancoast had only one-third as many patients to treat as he has now. If that were the case he would come before us at our next meeting with a smiling face and he would be one of the men who tell you that they can cure everything. And let me express the hope that at our next meeting we will have more papers on the program dealing with the therapeutic side of the X-ray.

I have treated several cases of sarcoma but most of them have died. I had two cases where I had little expectation of getting any result. Both were relatives of physicians. One had had a sarcoma of the right abdominal rectus which was removed by the physician. The peritoneum was studded with nodules when I began the X-ray treatment. Much to my surprise all these nodules have disappeared and the patient has gained 22 pounds in weight. He has not received any treatments for two months. Of course, that is only a temporary improvement and the man will die eventually from a recurrence. I admit that I am enthusiastic in this work, but I do not believe that I can cure a large proportion of my cases.

Dr. T. N. Holden, New York City: I think it is the experience of many workers along this line that we have not encroached so much on the territory of the surgeon as was supposed at the outset. The X-ray worker is not opposed to surgical measures, but the patient prefers non-operative treatment when he can get it.

At a recent meeting in New York, Dr. A. D. Bevan of Chicago gave us some very good points about the prognosis and treatment of malignant growths. He said that the prognosis in X-ray treatment was the same as in any other form of treatment. The prognosis is dependent upon the size of the tumor, the location of the tumor and the duration of the growth. As to size—the smaller the tumor, the better the prognosis; the larger the tumor,

the worse the prognosis. As to duration—a tumor which had existed for a short time, but which had a tendency to grow rapidly, always gave a bad prognosis. A tumor which had existed for a long time and which exhibited a tendency to slow growth, always gave a good prognosis. As regards location—the superficial tumor gives a better prognosis than a tumor situated deeply.

We know that there are small tumors that grow very rapidly, and that some large tumors grow very slowly; consequently we must take all these points into consideration when you make a prognosis. I think that there is only one class of cases that has been taken from the hands of the surgeon, and that is now treated exclusively and successfully by the X-ray operator, and that is lupus vulgaris. Another class of cases that can quite properly be treated with the X-ray is the superficial skin tumor, the non-malignant epithelioma. In the case of other tumors it is preferable to give the patient the chance of a primary operation, this to be followed by treatments with the X-ray. Do all you can with surgery first and then follow with the X-ray.

Dr. Bevan also spoke of some work they had been doing in the way of combining drug treatment with the X-ray. A number of tubes were filled with an emulsion of starch and potassium iodide, just as they would to a specific case, saturating the system. They seem to get better results from the combined action of the iodine and the ray than they would get from the ray alone. This experiment is worthy of our attention and I hope that some of you will take up this matter. He also spoke of using Fowler's solution in these cases.

As to statistics of cases treated and cases cured or improved, it seems to me advisable to agree upon some division of our cases so that we will know just what is meant when percentages are given. For instance, let us divide our cases into three classes. First, those cases that are operable but refuse operation. Second, those cases that are inoperable. Third, those cases that are absolutely hopeless. By doing this we could not only express ourselves more definitely as to what we are doing, but we will not discourage each other by giving a large percentage of cures, when, perhaps, all the cases were of the first class. Some operator who has been unfortunate enough to have all his cases come under the second or third class would give us a very unfavorable

report and it would, in a measure, prevent some men from taking up this work, men who would do a great deal for their cases as well as for the work itself. It seems to me, therefore, that such a division of our cases would do much to give us more definite information.

DR. DEFOREST WILLARD, Philadelphia: I am very much pleased to hear Dr. Pancoast say that he is hopeful. His report is a good one and, I think, he takes the proper ground when he says that we are yet in the experimental stage of treatment by the X-ray. I also agree with those who have said that we should combine surgical measures with the X-ray; first removing as many diseased cells as possible, then applying the X-ray for its therapeutic effect. I have great confidence in the X-ray in selected cases, but I also believe that it should be employed in connection with surgical measures wherever possible. Of course, there is a large class of inoperable cases, and another class that is absolutely hopeless, and yet even in these we can remove much tissue with the knife and then fall back upon the X-ray to do the rest.

There are many diseases in which the use of the X-ray is still in its infancy. We know but little about its efficiency and how it should be used; but let us all work together as surgeons and as therapeutists. Let us encourage our patients even if they cannot be cured. We can assure them, at least, that they can be relieved, that they can be made more comfortable, and even if they must die our efforts in their behalf have not been in vain. The fact of being able to make such a hopeless case peaceful for a few months or a year is of the greatest consequence to that unfortunate individual. Many people of 70 or 80 can die relieved from pain under the X-ray—people who otherwise would suffer greatly, therefore let us do what we can, even if a cure is out of the question.

DR. GEO. E. PFAHLER, Philadelphia: I agree fully with all that Dr. Willard has said, and also with what Dr. Johnston said. I believe that we should allow the surgeon to remove all tumors that are operable, and also so much of the tumor in inoperable cases as is possible, because I am quite sure that in these cases we lessen our work very much and remove the possibility of having a toxemia that we all have seen. I believe, too, that the X-ray

should be used in all those cases that now seem inoperable or hopeless. I have had cures in cases where none were expected; cases that were expected to die in a month and are living and well to-day. So that even hopeless cases should be given the benefit of the X-ray.

I would like to emphasize what Dr. Johnston said that our failures should not be counted against the X-ray but against ourselves as operators. Our successes simply mean that we have used the proper technique and that the case was treated as it should have been treated. Our failures *may* mean that our technique is not the proper one or that we do not know all about the case in hand. Under other circumstances such a case might have been cured.

DR. WM. C. EGELHOFF, Chicago: My experience in the treatment of cancer of the uterus differs from that related by Dr. Pancoast. I have had a number of inoperable cases that I have treated through the abdomen without the use of a speculum. Some of these cases were saturated with carcinoma. In several of the cases there was an extremely offensive discharge, which, after eight or ten treatments became very much less in most of the cases and in one it disappeared entirely after the seventh treatment. The same was true of the pain. Most of these patients had very severe pain; it disappeared in one case after the fifth treatment, and it was diminished considerably in most of the other cases. Unfortunately these cases were dispensary cases that ceased coming for their treatments so that I am unable to report the final outcome of the cases. I rayed all the cases in the recumbent position, both over the abdomen and over the spine, without any ill effect.

So far as carcinoma of the skin is concerned, I think we have in the X-ray a great remedy. I have had some very good results, and some of my cases were unusually interesting. I exposed these cases three times a week from seven to fifteen minutes each time.

I have also had a number of cases of cancer of the lip, most of which recovered completely, but have had some rather varied experiences, especially in one case, which had been pronounced carcinoma by a skin specialist. It presented itself in the form of

a large number of small nodules. After a prolonged course of treatment these nodules neither increased nor diminished in size, although the pain was lessened considerably. The case, being a dispensary case, disappeared in time.

I am inclined to believe that the X-ray will affect not only the superficial cancer but also the deeper malignant growths provided we persist in our treatment and do not use too strong a current or too much "juice." Some of these cases have been treated very harshly by some X-ray workers. I have had most excellent success with a very mild current and a low tube.

DR. RUSSELL H. BOGGS, Pittsburg: I wish to mention a case of keloid that I cured after a year's treatment. It was located on the right cheek and was about the size of a dollar. I exposed the case three times a week for a period of about six weeks, and then the growth had almost disappeared. I then followed up the treatment twice a week for about four weeks. Then I gave a few irregular treatments in order to prevent a recurrence.

There is one point that has not been dwelt upon to any extent, and that is in regard to the manner of the operation. This is of importance, particularly in the treatment of cancer of the breast. I have treated eighteen cases of cancer of the breast during the past year. Some of these cases have done very well, whereas others have not done so well. But the cases that yielded the best results were the cases from which the glands in the axilla had *not* been removed. In those cases from which all the glands and the muscles as well had been removed, and in which there was a recurrence, the treatment was not very satisfactory. I think that this is a point that should be dwelt upon more fully, and I would like to know whether any other operator has had this experience. I have two cases under treatment now and the mass is decreasing in size very rapidly.

One of these cases came to me about eight weeks after the operation. There was a mass about two-thirds the size of my fist. I treated the case for about five months, exposing it every day with a very low tube, and the mass began to decrease in size at the end of the second or third week. At the present time it is not more than one-fifth its original size. The patient is free from pain; in fact, has improved in every way.

I have had some experience with the treatment of sarcomata, but have never succeeded in curing a case, although the growth was retarded.

Dr. Wm. H. Dieffenbach, New York City: I was very much pleased with the tone of Dr. Pancoast's paper, especially the animus of it. He is not afraid to report his failures, which are of as much value to us as his successes. In the past two and a half years Dr. William Harvey King, of New York, and I have conducted a very large therapeutic clinic at the Flower Hospital, and we have given the treatment by the X-ray considerable attention. We have treated quite an array of cases, and although we were very enthusiastic at the beginning of the first six months, we have now come to look upon these cases with a somewhat critical eye; consequently we are now somewhat less enthusiastic than we were at the beginning of our work.

The class of cases that we treat are somewhat similar to those treated by Dr. Pancoast; cases that the surgeons refuse to operate; cases that are given up by the skin specialist as hopeless and incurable; cases that really are past all hope. If, therefore, we can take some of these cases and help them, palliate them, we consider that we are doing good work even though the number of cures is no higher than ten per cent., the percentage that Dr. Pancoast says he cures. I believe that our percentage of cures is somewhat larger than this, and I have hopes that it will increase as we come to study our cases more carefully.

I think that it cannot be emphasized sufficiently that in addition to the treatment with the X-ray each one of these cases should be given the benefit of constitutional treatment. It is a serious mistake to treat a case locally only; these cases also require constitutional treatment, and if this is combined intelligently with local treatment the result will be a much better one.

In regard to curability, we have found that lupus vulgaris and even lupus exodens, have shown remarkable improvement under the X-ray treatment. In fact, I can say truthfully that I call to mind but a single case that was not thoroughly cured.

The next disease susceptible to cure by X-radiation is lupus erythematosus. We have succeeded in completely curing one case, and another, now under treatment, is showing decided im-

provement. This is a disease which, you know, is considered to be incurable by any other form of treatment.

The three malignant diseases which we have found most amenable to treatment is discoid epithelioma, epithelioma proper and primary scirrhus carcinoma of the breast. I cannot agree with some of the surgeons that it is always best to remove a primary carcinoma and follow this with treatment by the X-ray. I have seen some results that were not very favorable to that procedure. The lowering of the vitality of the tissue through surgical interference prevents the X-ray from doing as good work as it would if it had been the only form of treatment used in that particular case. If the tumor is so large that it produces a toxemia from the destructive action of the X-ray, then surgical interference is justified. But if the tumor is small this is neither necessary nor justifiable. I have seen such tumors fairly melt away under X-ray treatment. We have cases in which the diagnosis is unquestionable that have improved. But we have also had failures, and I am unable to account for some of the failures, except that in some cases, where a blood examination was made, we found a decided leucocytosis and a decided lowering of the hemoglobin percentage and of the number of red corpuscles.

The one condition that we have found less amenable to treatment than any other is sarcoma proper. We have not cured a single case of sarcoma. Why, I am unable to say. Perhaps the disease is so far advanced that operation could not be indulged in and the case was then referred to us. The surgeons turn them over to us to try what we can do for them. A number of the cases have died in the hospital from toxemia.

Dr. Chas. L. Leonard, Philadelphia: I am a firm believer in the value of the X-ray as a therapeutic agent, but I am convinced that we do not yet know as much about it as we should or as we will later. More study is required before we will know all there is to know about the X-ray.

I also wish to put myself on record as believing in operation primarily in every case of malignant disease where operation is possible to be followed by the X-ray treatment. I also wish to call your attention to the value and efficiency of the X-ray as a palliative agent in the non-operable cases of malignant disease. In

this connection I will take the liberty of citing a few cases that I reported a few weeks ago before the Kings County Medical Society of New York. The following is an extract of my paper read at that time:

"A brief review of the effects produced in some cases of malignant disease will illustrate its (X-ray) efficiency and also show that there is a reasonable expectation of further developments. The cures and palliations so far effected form a sufficient ground for the opinion that this method of treatment should be employed in all cases of malignant disease either post-operative as a prophylactic and supplementing operation, or as a palliative and possibly curative agent in inoperable cases.

Apparent cures have been produced in an epithelioma of the upper eyelid that had invaded the palpebral cartilage. The cosmetic result was perfect, no scar resulted, and the only defect was the absence of eyelashes, as the hair follicles had been totally destroyed. In a second case a recurrent nodule followed removal of the right breast and involved the brachial plexus so intimately that its removal was impossible. Its position had been determined by operation and its malignant character by microscopic examination. It disappeared after two months' treatment, and the patient has remained free from recurrence for eleven months.

All the cases in which post-operative treatment has been employed are free from recurrences. The time elapsed, however, is not sufficient upon which to base definite conclusions. It is noteworthy that sinuses and granulating areas healed more rapidly under treatment, and that in cases of breast amputation all the patients recovered the use of the arm more rapidly and have gained in weight. One case of hysterectomy for malignant disease has remained free from recurrence for over a year.

Two cases of hopelessly inoperable disease deserve special mention. They illustrate the possibility of palliation, and one is particularly instructive since it demonstrates the power of this agent over deep-seated disease. It makes it probable that future developments in technique will render this agent effective in deep-seated growths.

The first patient, a lady of 70, had had for twelve years an atrophic scirrhus of the right breast. Fourteen months ago it

began to spread rapidly. Rœntgen treatment produced a healing, although the course of treatment was abruptly terminated by an accident which confined the patient to bed. This course of treatment, though it healed the ulcer and removed all external induration, did not reach the metastases. Four months later a sudden dysphagia developed. A tumor was found rising above the clavicle on the right side. She was unable to swallow her saliva or a teaspoonful of water, and was kept on rectal feeding for two weeks before she was brought to the city for treatment. The smallest oesophageal bougies were tried but could not be passed and brought away blood in spite of the greatest care. She was in a very weak condition when first seen, confined to her bed.

Energetic treatments were applied for ten minutes every other day. The area treated included the axilla, neck, right chest and mediastinum. After the fourth treatment she began to swallow a teaspoonful at a time. At the seventh treatment she drank a glass of egg-nog and then began to gradually take solid food. The skin withstood the severe treatment remarkably, and gradually took on a dark tan with a parchment-like appearance. So long as a dry stearate of zinc powder was employed, there was no ulceration, but a gradual exfoliation of the epidermis. A stearate of zinc ointment applied by mistake produced too great softening and an ulceration which, however, healed rapidly. The tumor above the clavicle disappeared, the patient rapidly regained her strength and resumed her usual life. She has occasional difficulty in swallowing but is very comfortable. The treatments have been continued for prophylactic reasons, increasing or decreasing in frequency according to the symptoms. Much of the time she has come from her home, a distance of eighty miles, once or twice a week, returning the same day.

Although the patient cannot be considered cured, the remarkable relief from a condition that was beyond all surgical aid and a prolongation of life for ten months (now fifteen) can be considered a result of the Rœntgen treatment. The disease is under control and her life may be lengthened many more months.

Another inoperable case was seen by a prominent surgeon who refused to operate and advised Rœntgen treatment. The patient was very weak but was finally brought in a carriage for the first treatment. He was about forty years old and had a sar-

coma of the left tonsil that nearly filled the pharynx. The lower border could not be seen and there was a distinct swelling behind the angle of the jaw. Treatments were applied both internally and externally. The patient's general condition improved rapidly, the tumor gradually decreasing in size. The tonsil has become nearly normal in size, showing only slightly below the half arch of the soft palate. He is still receiving occasional treatments and will remain under observation for sometime. He has attended to his insurance business for the past two months (now six months).

The palliative effects in a case of cancer "en Cuirasse" resulted in a complete freedom from all ulcerations and the absorption of a large tumor in the breast that had not been operated on. When first seen ulcerations and indurations occupied the line of the scar and the region over the sternum, and the case was operatively hopeless. She lived eighteen months after treatment was commenced and died from visceral lesions that interfered with respiration and deglutition. There were no ulcerations and the tumor mass has disappeared. Such palliation is impossible by other means.

One of the later and possibly more valuable applications of this method of treatment is illustrated by the following case of neuralgia, though the effect is not entirely analgesic but also produces a regeneration of the nerves themselves.

This is seen in the effects produced in a case of paralysis of the arm, with a partial paralysis of the leg which was the result of contracting scar tissue in the motor area. The patient had had an abscess removed ten years before; the relapse was said to have followed a recent accident. The arm was completely paralyzed, the skin of the hand was glazed and free from wrinkles; there was marked ankle clonus and exaggerated knee-jerk; the speech was halting. After nine treatments applied to the motor area through the trephine opening, the patient was able to raise the arm to the level of the shoulder and could grasp and hold small objects. The treatments were applied to aid in the absorption of the scar tissue and probably stimulate regenerative processes in the nerve cells. The result cannot be attributed entirely to the rays as the patient continued the use of bromides.

The first case of neuralgia treated involved the eye-ball and the supra and infra-orbital nerves. The pain had resisted energetic medical treatment and local applications. It was controlled by a three-minute treatment and cured by five applications.

The third patient, a man of about forty-five, had been a sufferer from neuralgia of the head and face for ten years. The superior and inferior dental nerves on both sides were involved in the present attack which had lasted for more than six months with great severity. The teeth were loosened and so tender that he could not close the jaws or chew solid food. His sleep was broken and he was rinsing his mouth with Jamaica ginger to get relief by the counter irritation produced. Three treatments on alternative days relieved the pain entirely; at the end of eight treatments he could close the jaws and chew solid food. He has received no treatment for more than three months and has remained free from pain.

In these cases the treatment must be applied with the greatest care, especially about the face. The object is to stimulate regenerative processes, and over-stimulation and injury must be avoided. As in all other treatments, each case is a law unto itself, and the best results can only be secured by determining and applying the dose required by the individual.

Dr. E. G. Williams, Richmond, Va: I wish to add my voice to that of Dr. Johnston, of Pittsburg, in saying that we have a very wonderful therapeutic agent in the X-ray, and that our failures may be due to the technique rather than to the agent. We know that the X-rays are produced by many variable and controlling factors, and it is the relative combination of these that produces the result.

The first case I had was a cancer of the lip. A few days after I began treatment the growth seemed to increase in size. The patient became frightened and suggested operation, and, not knowing what the result might be, I approved the suggestion. The tumor was excised, and when I examined it microscopically I found that the epithelial pearls had already begun to atrophy and the cells to degenerate, so that the lesion certainly would have healed under the X-ray treatment. A few days afterwards a similar case turned up and I felt confident that it would get well

and so informed my patient. In five weeks the case was entirely well.

A short time ago I had an opportunity of performing an autopsy on a case of recurrent carcinoma of the breast after I had treated it with the X-ray. The mass occupied a position in the scar, and was adherent to the skin. When the case first came to me improvement followed the treatment, and continued for about two months. The nodule had diminished considerably in size, but because of a dermatitis that had developed the treatment had to be discontinued for a time. When I was ready to begin the treatments again I saw that the growth had increased in size. The patient seemed to hold her own for about six weeks when she suddenly grew worse. The growth did not apparently increase in size, but her general health failed rapidly. She died about four weeks afterward.

At the autopsy I found that there were no cancerous growths in the anterior wall of the chest except the original nodule. Neither the remaining mammary glands nor the axillary glands were affected. The growth had extended deep, involving both lobes of the lung (right). The liver contained a number of cancerous nodules, and on the anterior surface of the heart was a nodule about the size of a pea. Metastatic growths found in both kidneys and the ovaries were masses of cancerous tissue. A microscopic examination was made of one of the liver nodules, and it showed a most remarkable number of karyokenetic figures, an evidence of very rapid growth of the tumor cells. Thus the part that had been exposed to the X-ray did not show any metastases, the rays evidently having checked or prevented their growth. But as the rays did not penetrate deeply the growths within may have been stimulated, which, perhaps, accounted for the exceedingly rapid development of tumors throughout the body.

DR. CHAS. WARRENNE ALLEN, New York City: I congratulate the doctor on his paper. Although his results are not at all brilliant, yet the paper has taught us many things, and it has served to bring out a most interesting and instructive discussion. The reader has been unfortunate in having to treat these very bad cases, the hospital cases, which, as he says, are unsatisfactory cases to treat for many reasons. I have been much more fortunately situated in my work in that I have not done any public

work. All my work is done in my office, and I have practiced what has been to-day advised by so many here, I have combined in my treatment everything that could possibly be of any benefit to my patients. From the very beginning of treatment by X-ray I have given my patients internal and other external treatment as well, and I think my results have been excellent.

I have never been an enthusiast about the X-ray therapy. I am to-day more enthusiastic than I have ever been, but I am still not an enthusiast, just because of such cases as were exhibited to us this afternoon. Almost all the deep-seated cancers and cases of cancer of the breast that I have treated were practically hopeless, and, of course, this decreased my percentage of cure very decidedly. But taking all the cases of cancer that I have treated, 95 in number, my percentage of clinical cures is about 33 or 34. This includes those still under treatment. If I should exclude the hopeless cases, that could not be benefited by any form of treatment, my percentage would run up to about fifty, because at least half of my cases of skin cancer are cured to-day. These figures include five cases of cancer of the lip. Of these five four are cured, so far as I know. I have seen some of them at times since their discharge, because I have them come and report to me occasionally. The fifth case was made worse by the ray and had to come to excision, because, perhaps, I did not do all I should have done. I did not use the caustic paste to burn it out, as I have done in other cases. From my standpoint the use of the caustic paste is a better surgical procedure than cutting with the knife.

There are so many things that the paper has brought up that it is impossible to discuss them all. The author mentioned the effect of the ray on the eye and the possibility of putting the ray directly into the eye. This can be done. I am now treating a boy with xeroderma pigmentosum which had involved both eyes in cancerous degeneration. One eye has been enucleated; the other is improving. Nothing will do that boy any good if the ray does not do it. It has cured a number of very large cancers on this patient's face, cancers that had already involved the inner canthus and which had penetrated deeply into the periorbital tissues. The ray has cleared them up, doing what nothing else will do so promptly and perfectly. Of course, you could

put the paste on in this situation, and I have often done so. Within a week I have applied the paste in a case in which a rodent cancer came right up to the inner canthus. The paste will eat out a cancer very nicely, but the ray is capable by itself alone of causing deeply penetrating cancers in this situation to disappear, thus saving an eye that would otherwise be surely lost.

DR. WESTON A. PRICE, Cleveland, O.: One of the lesions that is ameanble to treatment with the X-ray that has not been mentioned is pyorrhœa alveolaris, a very intractable condition. I have used the ray in a number of these cases and the results have been extremely gratifying. Every case that has been treated in that way has shown some improvement, and many cases show a marked improvement, but I have not done the work long enough to predict just what will be the outcome. Even very bad cases, cases in which the teeth were loose and the roots bathed in pus, have been improved so that pus formation has ceased, the teeth are becoming fixed in their sockets and the patient is more comfortable. That is more than we can achieve with any other agent. I am not universally successful, but I am satisfied that in the X-ray we have an agent that will cure, or at least do much toward establishing a cure, in pyorrhœa alveolaris.

DR. PANCOAST (closing the discussion): I am very much pleased with the discussion on my paper, and am certain that it will be a help to us all to have received so many comments and new ideas. There are many more things, however, that I wish had been taken up and discussed, but presume that this paper with its discussion has consumed more than its share of the time allotted to it on the program.

Dr. Boggs mentioned a point in connection with the removal of the lymph glands in cancer of the breast that is deserving of extra attention. While I think it is a safe surgical procedure to always remove the axillary lymph glands in operating for carcinoma of the breast, yet I have no doubt but that their removal has in many cases a tendency to influence the healing of the breast, in case of X-ray treatment for a recurrence. Many of you may have noted this fact. Take any growth in a region which is well drained by lymph glands, and often you will find that during the treatment with the X-ray the glands at first are

greatly enlarged; then the enlargement subsides or apparently disappears entirely so that the glands are no longer visible. Then they may again enlarge, but only to disappear as in the first instance. I have noticed this particularly in cases of carcinoma of the uterus and vagina, and also in a case of fibro-adenoma of the breast occurring in a woman of thirty-six. At intervals the axillary lymph glands became enlarged. I suppose this is due to a draining from the growth of toxic products from the destruction by treatment.

TREATMENT OF LUPUS AND EPITHELIOMA BY THE COMBINED USE OF THE X-RAYS AND ULTRA-VIOLET LIGHT.

In the absence of Dr. J. N. Scott, Dr. Geo. G. Hopkins, of Brooklyn, N. Y., spoke as follows:

Mr. President—As may be known to some of you, I am an enthusiastic advocate of the therapy of light. As far back in history as we can go, light has been considered a therapeutic agent. Even the ancient Romans had special sanatoria in which the treatment of light was the only treatment pursued. Nearly all the larger houses of Pompeii were so equipped and it was the good fortune of a gentleman in the southern part of this country to revive the idea of the therapy of light.

In 1832 Dr. Picton, of New Orleans, La., announced the fact that the pitting of smallpox could be prevented by the exclusion of light; the absence of pitting meant the absence of suppuration; the absence of suppuration the decrease in temperature; the decrease in temperature conserved the strength of the patient, with the result that the duration of the disease was greatly reduced, suppuration not having occurred, there were no scabs to disseminate the disease; that the fever could be almost annihilated by placing the patient in a dark room, that is by excluding the light. His discovery was purely accidental. A number of prisoners confined in some dungeon developed smallpox and he observed that the disease ran a very mild course; and that it was robbed of many of its horrors. He studied this thing and wrote a thesis on the subject. It was published but excited little attention at the time. A stray copy of this thesis found its way to Iceland, and in 1893 Dr. Niels Finsen, a physician living in Iceland, found that copy and it set him to thinking.

Dr. Finsen went deeper, however, than did Dr. Picton. He had an idea that certain rays of light were particularly destructive to germs and he carried out a series of very extensive experiments to prove this. He experimented on in-

sects and on worms and finally came to the conclusion that it was the blue, the violet and the ultra-violet rays of the spectrum that were particularly destructive of the lupus germ, and that the red rays were destructive of the smallpox germ. I find that the former are also destructive of the cancer germ.

His first experiments were conducted very quietly. In September, 1893, Dr. Svendin, of Bergen, Norway, put the idea to a practical test by constructing rooms into which nothing but the red light was admitted, and confining his smallpox patients to these rooms. He found that the slightest admission of ordinary light aggravated the disease very promptly. But in patients confined entirely to these rooms, patients exposed only to the red light, the suppuration was checked, and by checking the suppuration the fever was reduced. By preventing the pustules no scabbing resulted and the patients made a rapid and uneventful recovery.

Dr. Benghardt, of Gothenberg, followed along the same lines and both he and Dr. Svendin have declared very emphatically that in the case of a large number of smallpox patients the treatment was absolutely curative. If, then, we have in the red light a remedy that is so simple, effective and useful it is outrageous that the authorities of the various cities all over the world should not adopt this measure. It is a very inexpensive measure to put to the test. We have the evidence of men whose veracity we cannot question, and their observations undoubtedly are correct. I think it is criminal that the treatment has not been pushed in this country and in other countries. I believe that we can exterminate smallpox if we will follow out Finsen's plan.

Dr. Finsen certainly is a very great man; he is more than that; he is a martyr to the cause. He is a very sick man and many of us, if in his condition, would go to bed and stay there. When I saw him last I could hear his heart beating several feet from him. He had been tapped three months before and was expecting to be tapped again. He is never without pain and yet he is devoting himself unremittingly to this work for the welfare of mankind. He has never received a fee for his work, and is treating his cases as a public official, being salaried by the Danish government.

Having conquered smallpox he looked for other diseases to conquer. In that little country of Denmark there are thousands upon thousands of cases of lupus. After some thought he came to the conclusion that by using a quartz crystal lens, which cuts out the heat rays of light, the yellow, orange and red rays, he could cure this loathsome disease. Had I known that I was to occupy the principal part in this discussion I would have brought a lot of photographs that Dr. Finsen gave me showing cases both before and after treatment by this method. I have a case under treatment now in which the whole face was covered with lupus. The left ear had been eaten away; the nose was going and the disease was crawling into the left eye. That patient now has cicatrical tissue over the greater portion of her face and within a few weeks she will be discharged as cured. Yet that case is not as bad as many that I saw in Denmark and which Dr. Finsen had cured.

A great injustice is being done Dr. Finsen in this country by the substitution of instruments that have comparatively little merit and that do not contain the rays that are transmitted through the quartz crystal lenses. When I started on this line of work I read a description of the instruments Dr. Finsen was using published in the British Medical Journal and the Philadelphia Medical Journal. I had Tieman, of New York, construct a tube for me. I got a quartz crystal lens, two inches in diameter, and all the other parts of the apparatus were constructed in accordance with the directions. When I visited Dr. Finsen in Denmark, I found that he had increased the diameter of his lens to three inches. My lens was fractured by heat and I sent all over the country trying to get a two-inch quartz crystal lens. Tiffany, of New York, placed at my disposal a ton of crystal. I picked out the best pieces, but Professor Brashear could not find in the lot an unfogged lens two inches in diameter. I went to Denmark and without any trouble whatever got a lens three inches in diameter. I constructed my lamp here on account of the different tension in my current. The lamp I use in this Finsen apparatus is an 80 ampere lamp. It burns an inch carbon and it takes about two horse power to operate the lamp. The

lamp has the same power and the same carbons as the lamp on Neversink Highlands, a twenty-four thousand candle power lamp. I modified the mounting of the apparatus so as to make it more adjustable to the patient. In place of adjusting the patient to the apparatus I can now adjust the apparatus to the patient. In Copenhagen the lamp is hung on four supports which must be altered if you change the position of the lamp. I mount my lamp with two staples, a pin running through the arms of a yoke and attached to the lamp and a sextant with a screw so that I can tilt the lamp. On top of that I had a piece of tubing fastened to the protector on the ceiling, and to that secured a clamp screw so that I can slide the rod up and down, and in two seconds I can alter the position of the lamp. The Finsen tube is fixed by a rod of the frame which encloses the lamp. I removed that, and now have a stand on which I can mount the tube and adjust it to any angle desired.

I have done this particularly for the treatment of uterine cancer and I am using today with very satisfactory results the X-ray and the Finsen light in the treatment of uterine carcinoma. The claim has been made here today that we get ten per cent. of recoveries in these cases. I believe that we should feel encouraged at that percentage because we get the cases that nobody else can do anything with. When we get our proper modicum of cases; when we get breast cases before the glands are involved; when we get uterine cases before the cervix is all broken down, we will be able to show up a greater perecentage of cures than we do now. As it is we save ten per cent. of the cases that are doomed to die.

The first case of uterine carcinoma that came to me for treatment had been given only three weeks to live. She had very severe hemorrhages and she was so weak that she had to be carried to my office for the first six weeks that she was under treatment. I found that the X-ray controlled the disease but the Finsen light controlled the hemorrhages. She used to pass as much as a quart of blood at a time and could not raise her head from the bed without having a hemorrhage. She came to me on the fifteenth day of January and on the first day of June she went home and resumed her household

duties. If we can do that with these desperate cases, surely we can do more for the cases that come to us earlier in the history of the disease.

Another point in which Dr. Finsen has antedated the X-ray is in the use of his light in post-operative cases of malignant disease. Long before the X-ray was suggested he was using his lamp after amputations of the breast and other parts of the body with admirable results. While the Finsen light treatment is tedious, yet it is entirely without risk; but we all know that the treatment with the X-ray is not without risk. There are, of course, certain cases in which the Finsen light does not penetrate deeply enough to reach the diseased tissues; therefore, it is useful only for comparatively superficial cases. In cases where we must penetrate deeply we must use the X-ray and the field of possibilities that will be opened to us when we understand the advantages and disadvantages, the scope and limitations and the technique of the X-ray better is beyond conception.

Dr. Waite criticised the term hard and soft tubes. I believe we are all right in our designations. We might as well criticise the nomenclature of the whole category of disease because all our designations are purely empirical. It is possible that some day we will get down to using a scientific nomenclature of diseases and instruments. Today we are on the borderland. Some fifteen years ago the present president of the American Electro-Therapeutic Society read a paper which I was asked to discuss. In the course of my remarks I said that electricity was in its infancy. Dr. Rockwell took exception to that and said that electricity was a full grown man. Two years ago I had occasion to discuss another paper at the Academy with him and I repeated my statement that electricity was in its infancy. And I believe it is still in its infancy.

A word in regard to radium. In this metal we have something that in its effects is analogous to the X-ray. I have been fortunate enough to secure some of it. I have a tube of glass, cone shaped. The glass tube is sealed, has a handle, and is filled with radium, 7,000 activity. I have had made a perforated steel needle which I attach to a hypoderm-

ic syringe, and of exactly the same size and shape as the glass tube containing the radium. I fill the syringe with cocaine solution, attach the steel needle, inject the cocaine ahead of it until the syringe is in up to the butt. That gives me a tract that is absolutely insensible. Then I take the glass tube and carry it up into the tumor in the track of the needle and leave it there for as many minutes as I desire.

I have another tube of a broader shape that I use for special cases. I had one case of cancer of the uterus in a virgin of 60. The introduction of a speculum was so excessively painful that I had to discontinue the use of the X-ray. I concluded to try radium. I took a test tube and carried it up into the vagina until it touched the cervix. I introduced the radium tube inside of that. When I began to treat that case six weeks ago there was a great deal of deposit, and the hemorrhages were frequent, but today I feel that there has been a great change in the interior of that cavity. I did not try to examine the patient digitally because of the great pain it would occasion and also because of the shock it would cause her. I exposed for five minutes.

The same patient had a sore on the second finger of the right hand that had existed for five years. I treated that with the radium and it has healed up nicely. Possibly that sore was of the same nature as the uterine trouble. Her general condition has improved very much and the discharge has lessened.

We do not know what radium is going to do for us. At our next meeting we may throw away our X-ray apparatus and adopt radium because we believe that it is better than the X-ray. I took my radium tube one day, wrapped it up in cotton, placed it into a wooden box and then laid it into a bureau drawer. Then I took a photographic plate, wrapped it up first in black paper, then in brown paper and laid on it a fifty cent silver piece, three quarters and a lot of pennies. I left them there for ten hours and when I developed the plate I had an over-exposed plate showing that the penetration of the radium is equal to that of the X-ray.

We are in an age of discovery and what the next year will bring forth we cannot say.

DR. PRICE—I would like to ask what was the distance of the radioactive salt from the photographic plate.

DR. HOPKINS—About two inches.

DR. JOHNSTON, Pittsburg—Dr. Hopkins said that his experiments had proven that the penetration of the radium rays was equal to that of the X-ray. I should like to have him take a tube of radium and make a radiogram of a kidney stone in about four minutes.

DR. HOPKINS—I believe that I could do that with radium that will arrive shortly. It has 300,000 actinic activity. The specimen is being imported for the Museum of Natural History in New York and the curator has promised to loan it to me. When it comes I will experiment with it as to its action on photographic plates.

A COMPARATIVE STUDY OF FRACTURES OF THE EXTREMITIES.

BY M. I. WILBERT,

Director of the Radiographic Laboratory at the German Hospital, Philadelphia, Pa.

Stimson, in the introduction to his book on fractures, says: "A fracture, in the surgical sense of the word, is the breaking of a bone or a cartilage."

If this rather liberal definition of a fracture be accepted as correct, we must recognize as fractures quite a number of injuries that were formerly classed as sprains. This would also agree with the definition of the word sprain, as usually accepted. "A sprain is the violent straining or wrenching of the soft parts surrounding a joint, without dislocation, and without a fracture of the bony structure."

While it is true that as far as a verbal definition goes, there is no possibility here of mistaking the one for the other. This is not so readily done in actual practice, where it not infrequently happens that even an extensive injury to the osseous framework may be, and sometimes is, mistaken for the more simple lesion. That many cases of actual fracture, particularly at or near the articulating portion of the long bones, have gone unrecognized and untreated, is evidenced by the well-known popular saying that "A sprain is ofttimes worse than a fracture." This saying is well founded on the fact, that when a fracture has been diagnosed as a sprain, and treated as such, it usually results in an exuberance of callous that, almost invariably, causes subsequent impairment of function.

Every X-ray operator has no doubt had ample opportunity to learn the variety, and also the frequency of these mistaken diagnoses, so that it will not be necessary to go into this phase of the question at greater length at this time.

As an additional proof of the correctness of the statement, however, we should like to call your attention to the following

table of figures, comparing our statistics of total fractures with those published by Stimson:

TABLE NO. 1.

	Stimson.	German Hospital.
Head and Neck	15	7
Trunk	11	5
Upper Extremity	52	57
Lower Extremity	22	31

Table No. 1—Giving comparative figures of frequency of fractures.

It will be noted that there is quite a marked discrepancy between the comparative numbers of fractures of the extremities and fractures of the remaining portions of the body.

While this difference may, to some extent, be due to our own peculiar environment, and to the class of industrial establishments from which many of our patients come, these purely local conditions will not account entirely for the variations in the accompanying figures, particularly as these figures have proven to be fairly constant over a period of now nearly eight years.

We ourselves believe that the difference in frequency of fractures of the extremities is entirely due to the more accurate diagnosis of injuries to the osseous structure, that has been made possible by the introduction and systematic use of the X-rays

One other feature in connection with the statistics emanating from the radiographic laboratory of the German Hospital, that we should like to call your attention to, is the fact that they differ from those ordinarily published, in making a distinction between a fracture in the shaft of a bone and an injury at or near a joint. This we believe to be justified by the greater relative importance of a fracture at or near a joint, and also by the fact that injuries at a joint, in a large number of cases, involve more than one bone. The recognition, and correct diagnosis of joint fractures, besides being of practical importance to the rational treatment of a patient, is also of considerable interest and of vital importance from an economical point of view.

TABLE NO. 2.

Upper Extremity.

German Hospital.		Stimson.	
Hand	12.0	Hand	10.0
Wrist	25.5		
Arm	5.0	Arm	22.25
Elbow	12.5		
Humerus	1.5	Humerus	10.0
Shoulder	7.5	Scapula	1.25
		Clavicle	19.0
Total	64.0	Total	62.5

Lower Extremity.

Thigh and Hip	2.5	Thigh	7.5
Knee	4.5	Patella	2.5
Leg	5.5	Leg	18.5
Ankle	14.5		
Foot	9.0	Foot	9.0
Total	36	Total	37.5

Table No. 2—Showing comparative frequency of fractures in a series of 2,000 consecutive cases, compared with figures quoted by Stimson. Beck and others.

The accompanying table (No. 2) well illustrates the importance of this subject of joint fractures. If any additional argument were needed it might be found in the comparative frequence of fractures of the carpus. Carpal fractures, in textbooks on surgery are usually dismissed in a perfunctory way, with the statement that they are unusual or very rare. In our own experience, at the German Hospital, we have found them to be comparatively frequent, in one thousand consecutive cases, that have been reported, no less than eighty-two had a fracture involving one or more of the carpal bones, making a total of 8.2 per cent. of all fractures. To appreciate the significance of the figures quoted in the above table still more, let us consider for a moment the composition and mechanism of a joint.

In its simplest form a joint is composed of two or more bones suitably shaped and arranged. The articulating surfaces of these bones are covered with cartilage and protected by, or enveloped

in, a fibrous tissue which in turn is lined with a delicate secreting membrane.

The different bones constituting the joint are held together by ligaments of various kinds, and are acted upon by muscles, so distributed and attached as to facilitate movement in the required direction.

To supply nourishment and to control the motion of the various parts, we necessarily have a liberal supply of blood vessels and nerves. These, on account of the limited space available, are usually in close proximity to, or enveloped in, the surrounding structures. If we can conjure up a proper picture of any particular joint, realize its wonderful complexity, and its thorough adaptation to the particular purpose for which it is designed or used, we will readily appreciate why a comparatively slight injury may, and will, occasion considerable derangement of the normal function of that joint.

In connection with injuries to, or near, the articulating surface of a bone, too much stress cannot be laid on the caution to be careful in handling the part. Hamilton, in his justly far-famed treatise on fractures, calls attention to this fact, and says that, "The rude and reckless handling of a limb may result in serious additional damage that can never afterward be wholly remedied, augmenting the pain and inflammation and not infrequently, no doubt, determining the occurrence of suppuration, gangrene and death."

In another paragraph, the same author adds that, "The surgeon should not forget, that while a patient is under the influence of an anæsthetic, violent manipulations are no less liable to rupture blood vessels, and to lacerate other tissues, than if employed when the patient is conscious."

Experience will fully justify these statements, made by Hamilton more than thirty years ago, in contradistinction to the advice given by some later writer, "to administer an anæsthetic to all cases that do not admit of ready manipulation for making a complete and accurate diagnosis."

The necessity of a complete and accurate diagnosis of an injury will readily be admitted. Some additional suggestions as to the value of a correct diagnosis, particularly of injuries about a

joint, may be had from table No. 3, giving the approximate age at which the various fractures occurred.

TABLE NO. 3.

	Age							
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	Over 70
Upper Extremity.								
Hand	3	30	26	24	11	3	1	
Wrist	5	60	59	35	36	32	14	2
Arm	8	20	5	6	4	3	1	
Elbow	36	33	14	10	13	4	1	2
Humerus	1	4	5	4	4	1		
Shoulder	4	7	19	19	9	15	8	4
Lower Extremity.								
Thigh and Hip	1	5	3	1	6	5	4	
Knee	3	5	9	7	6	5	2	
Leg	9	6	9	10	12	12	2	
Ankle	6	24	46	50	27	19	6	1
Foot	2	5	38	26	24	7		2
Total	78	199	233	192	152	96	39	11

Table No. 3—Giving the approximate age at which the injury occurred, in a series of 1,000 consecutive cases of fractures of the extremities.

A glance at this table will suggest the fact that nearly one-fourth (23.3%) of all the fractures, occurred in persons between the age of twenty-one and thirty. Forty-three and two-tenths per cent. of the fractures occurred between the ages of eleven and thirty. The economic value of these figures will appeal to us more when we stop to think that the average age of this particular number of cases would not be more than twenty-two, and that at this age the computed expectancy of life is at least forty years.

When we remember that the earning capacity of the average individual depends very materially on the full and complete use of the various joints of the extremities, and that it may be, and usually is, seriously impaired by the loss or impairment of this complete use of the joints, we begin to realize the value and importance of the X-rays as a diagnostic agent.

TABLE NO. 4.

	Sex.		Side.		
	Male.	Female.	Right.	Left.	Total.
Hand	88	10	55	43	98
Wrist	195	48	118	125	243
Arm	38	9	20	27	47
Elbow	92	21	48	65	113
Humerus	16	3	8	11	19
Shoulder	70	15	59	26	85
Thigh and Hip	20	5	15	10	25
Knee	28	9	21	16	37
Leg	43	7	27	23	50
Ankle	157	22	80	99	179
Foot	99	5	64	40	104
Total	846	154	515	485	

Table No. 4—Giving the sex and the side involved, in a series of 1,000 consecutive cases, of fracture of the extremity.

Table No. 4 has been introduced as offering some additional, and interesting data, in conection with a study of frequency of fractures of the extremities.

Among other interesting sugestions, the marked, and in many respects, distinct difference in the number of fractures involving the right as compared to the left shoulder, will immediately call to mind the more general use that is made of the right shoulder joint, in attempts to protect ourselves from possible injuries. The marked difference in the number of fractures of the hand or foot, occurring in males, as compared to females, is of course explained by the extra hazard taken by males in many of their occupations, particularly by those engaged in the manufacturing industries, in which iron and other heavy metals play an important part.

Another discrepancy found in the figures given for fractures of the leg and ankle can also be attributed to conditions more or less closely connected with the occupation of the individual. Aside from these exceptional cases, it is rather interesting to note how closely the remaining figures approximate the frequently suggested ratio of four males to one female.

There is one other feature in connection with fractures of the extremities that should not be lost sight of, which is embodied in a caution found in many text-books, usually accredited to Nela-

ton. This is to examine the remaining joints of the same extremity for additional injuries, as it not infrequently happens that an adjacent joint may be involved. This is particularly applicable in cases of fracture involving the shaft of one of the long bones, where the resulting deformity may, and frequently does, cause considerable disturbance at the adjoining articulating surface.

Fractures are frequently complicated by the deformity from an old injury; for some occult reason patients will rarely call attention to the previous deformity, and even when questioned will deny having had a previous injury, until confronted with unmistakable evidence of the presence of an old deformity. These same unrecognized, or unremembered, injuries to or near a joint, not infrequently play a very important part in the subsequent development of diseases of the bones.

Diseases of the joints are usually ascribed to some constitutional taint. There can be no doubt, however, that in a large number of cases they can be directly traced to a more or less extensive bone injury, received at some earlier period.

This of course suggests the question as to how many of these diseased joints could have been averted by the recognition of the true nature, and the proper treatment of the initial lesion. Without going at all into a discussion of the treatment of fractures, we should like to call attention to the possible damage that may be done in this direction by the not uncommon mistake of keeping a joint at rest for an inordinate period of time. The changes that may be brought about in the composition of a joint are of a grave and ofttimes serious nature.

The connective tissue that fills up the interspaces of the joint is most likely to be affected, as it is either compressed or unduly relaxed. In the former case it is likely to become dense, and hard; in the latter it is more likely to fill with fluid, become soft and pulpy and eventually undergo further changes, and ultimately cause more or less interference with motion, complete ankylosis, and possibly degenerative changes in the part. In conclusion we would like to say, that while it must be admitted that the X-rays, even at the present time, will not indicate the exact nature of all of the possible injuries to the extremities, they do, when properly applied, invariably show all serious lesions of the

osseous structure and, in a number of cases, will indicate correctly the nature and extent of the injuries to the soft parts; particularly when this injury involves the denser portions of the tendons.

It is reasonable, then, for us to assert that precision and exactness of diagnosis, without incurring any additional risk of injuring surrounding tissues, are practically impossible without the use of the X-rays, and that without a complete and correct diagnosis of an injury, the accompanying treatment must necessarily be entirely a matter of chance.

In this connection we feel satisfied that a more general adoption of the routine use of the X-rays, in all cases of possible injury to the osseous structure, will do much toward helping the human race onward toward that ultimate, and perhaps ideal, possibility of freedom from grave ills and unnecessary deformities.

DISCUSSION.

DR. RUSSELL H. BOGGS, Pittsburg: This is a very interest-paper, and I wish to compliment the essayist on his very systematic work. If all cases of fracture were examined in this careful way it is beyond doubt that no one would attempt a diagnosis without having obtained a skiagraph. He has had a very wide experience, and has shown conclusively, it seems to me, that fractures about and in joints occur very much more often than is supposed. Fractures should be examined not only for the purpose of making a diagnosis, but more particularly for the purpose of making a study of the nature of the fracture so that it can be treated properly. Repeated examinations of the same case are warranted in order to see what progress the case is making. Many fractures are not typical, and it is very difficult to keep the fragments in apposition.

I want to mention one other point, and that is in connection with the use of the fluoroscope. There are many X-ray workers in all sections of the country who depend too much on the fluoroscope in the examination of a fracture. It is far better not to make any examination at all than to use the fluoroscope. It is very unreliable. In the last year I examined a number of shoulder joint fractures with the fluoroscope and in only one case was

I able to make a diagnosis. In five cases in which a fluoroscopic examination was made the attending physician told me that he did not want to put the patient to the expense of having a radiograph made. In three cases chloroform was given and attempt made to reduce a dislocation when no dislocation existed. It was a case of fracture and in one case the fracture was complicated by a dislocation.

DR. JAMES B. BULLITT, Louisville, Ky.: I am sorry that Mr. Wilbert did not have time to read his paper in full, but the substance of it is like that of the paper he gave us last year. It is of the very greatest value and is most instructive. Dr. Hickey has lead us to believe that before long the chapter on the development of the bones will have to be rewritten, and Mr. Wilbert has shown us that before long the chapters on fractures will have to be amended and rewritten. The very great lesson that is to be learned from his paper is that very slight injuries should be given methodical and systematic examinations, and that they should also be recorded systematically. His methods in these two respects are almost perfect. Those of you who heard his paper last year will remember the system he uses for the recording of data and results. This is a matter of the greatest importance, and most of us must feel very guilty when we consider what we have done in the diagnosis of injuries of this kind.

In the grosser lesions, where even the surgeon without a radiograph can recognize the fracture, it is not a matter of so much importance. If there is a fracture of a large bone most surgeons can make a diagnosis without a radiograph, although it is always desirable to make one; but in the case of injuries that are considered minor, the greatest importance is to be attached to this method.

I have learned that many so-called sprains, especially about the foot where we find so often that the tip of the fifth metacarpal bone is broken off, are not trifling injuries as many suppose. I am convinced that in former times these injuries would have been diagnosed as a sprain or bruise and yet the radiograph shows us that the tip of the bone has been broken off.

His point of making a radiograph in order to assist us in the treatment of these fractures is also well taken. It is a matter

of great importance. He also showed us a picture of a fracture about the hip joint in which a perfect anatomical result had been obtained so far as the continuity of the bone was concerned, and yet the functional result was destroyed absolutely.

So far as it is proper to make a reference to treatment, this calls attention to the fact that immobilization for any great length of time is nearly always a very improper plan of treatment. The more modern plan of treatment, as insisted on by French surgeons, is that mobilization with massage is the best form of treatment. The anatomical result may not be perfect, but it is hardly less perfect than in many so-called treatments by the immobilization method. The functional results to be obtained by mobilization are very much greater. We owe Mr. Wilbert thanks for the important every day lesson he has taught us from year to year.

Mr. Wilbert (closing the discussion): I discarded the fluoroscope for diagnostic purposes a long time ago, and for various reasons. I found that so far as diagnosis is concerned it is absolutely useless, and the X-ray plates we use are so cheap that there is no excuse for not having a radiograph of every case that comes to our institution. The plate is filed away and we have a complete record of every case to which we can refer at any time. These records become more valuable every day because patients who have been treated in our hospital four or five years ago are continually coming back with new injuries.

So far as the treatment is concerned, that, of course, is out of my sphere, but the treatment in our institution has been carried out with the view of getting a functional result rather than an anatomical result. It is the more important of the two and so far as the patient is concerned it is the more desirable because he wants the use of his limbs even though they may not be anatomically correct. The patient's welfare is always to be considered and placed above the attainment of anatomical results.

DEVELOPERS.

BY GORDON G. BURDICK, M.D.,

Of Chicago,

Chief Surgeon People's Hospital; Professor Radio-Therapy and Photo-Chemistry, Illinois School Electro-Therapeutics; Associate Professor Surgery, Post-Graduate Medical School; President Chicago Electro-Medical Society.

A study of these important agents with reference to their value in skiagraphy is appropriate at this time. The diagnostic value of the X-ray is only feebly appreciated by surgeons. The result is that this branch of art is still in a crude and expensive stage. Few operators have had opportunities to develop skiagraphy down to a fine art. By mutual consent the different parts of this work have been left in charge of certain individuals, other operators having their hands full attending to the medical end of the business, and it seems impractical to combine both branches of this work under one head, as one or the other is bound to suffer if neglected.

Developers have certain characteristics that render each one peculiarly suitable for given conditions, so probably the best way to consider them would be in the order of their chromagenetic properties. We find that each developer imparts to the polarized silver molecule a characteristic stain, while reducing the complex molecule of silver bromide to the simpler form of metallic silver; and they might be considered first from the non-actino end of the spectrum, and, curiously enough, their value in skiagraphy decreases as the color moves upward toward the chemical end of the spectrum.

Ortal stands at the head of the list, giving a brown stain, a mixture of red and yellow, the only known member of this group.

Acid Pyrogallic—A brilliant yellow. This is the oldest known developer, and by old-time photographers considered the best for all purposes, which is probably true outside of large towns, where we have to contend with so large a propor-

tion of organic matter and gases in the atmosphere that a solution of this wonderful reagent is oxidized in five minutes when exposed to these influences and requires several additions of fresh developer before a skiagraph has been developed far enough to give us contrast enough to make a good proof. This agent has the serious drawback of causing a severe eruption to appear upon the hands of many people, which is very objectionable from the point of the X-ray operators.

Eikonogen gives an orange color and is free from the objections of pyrogallic acid, as it causes no irritation, works clearly and may be used repeatedly. However, it has two serious drawbacks from a skiagraphic standpoint. It is very slow in its action when not concentrated, requiring a full hour in order to give enough printing contrast; and if used stronger will reduce the bromide of silver not polarized by light, covering the negative with mirror-like spots in the shadows that have been mistaken for disease in many cases upon the positive proof.

Hydrochinon imparts a dark green stain to the silver molecule and enjoys the distinction of being the most contrasty developer known. This oxidizing agent has more curious properties than all the rest of the reducing agents combined. But time is too short to consider more than a few of them. This developer is interminably slow in its action, but acts as a clearing agent, building up the high lights at the expense of the shadows. It does not show the slightest disposition to veil or fog a plate, even if left in it for twenty-four hours. A negative developed by this agent has only two tones—high lights and shadows. The medium tones disappearing completely, being intensified at the expense of the shadows. So, by using this agent we get the outline shadows of bones, which are wonderfully clear and full of detail. But the disease of the soft tissue will not show up, being lost in the medium tones that merge into the high lights. This developer requires at least three hours to completely reduce the polarized silver to a simpler form and develop the plate as far as may be possible by this agent and of the bony structure gives the most delightful negative.

Metol gives us gray deposits, is not very non-actinic, but has the peculiar property of working very quickly and giving a

wealth of detail. Negatives made by this developer are remarkably soft, but all the finer tones show beautifully by transmitted light, and it is probably the best developer for stereoscopic skiagraphy.

Amidol, giving a blue black, is the last agent we will consider. This agent has the peculiar property of requiring less than one-tenth the exposure of any other agent and is the developer par excellence for instantaneous skiagraphy. If properly used it will give a very fine negative from very quick exposure. The negative is fine by transmitted light, but is so transparent to the actinic rays that good positives can rarely be obtained.

We usually require in a good skiagraph as much contrast as it is possible to get without spending too much time to get it, so that we usually select some developing agent that gives a good non-actinic color to the negative, and each one of our contrast developers has idiosyncrasies that makes it more or less desirable for different purposes.

In hydrochinon we have the agent that will actually strip the bones of flesh, killing all the half tones and building them up at the expense of the shadows. A negative developed with this agent is usually so harsh and requires so long a time to make a positive print that it is rarely used alone. Combination developers give better satisfaction, taking the good qualities of each, submerging the less desirable.

After trying nearly everything in this line of reagents, I have decided that a mixture of ortol and metol gives the best all-around negative for skiagraphy. I use it in the following combination:

(A)

Ortol	15 grams
Metol	15 grams
Meta bi-sulphite of potassium	8 grams
Bromide of potassium	4 grams
Aquæ dist.	1000

(B)

Aquæ dist.	1000
Sodii sulphite C. P. dry	60
Potassium carbonate, dry C. P.	90

Use 30 cc. of each and dilute with from 20 to 120 cc. of water, according to effects desired. The less water the more contrast, while by diluting the reagent more the softer the negative will be and the more detail will be seen.

The ortol is used because it imparts a brown color, which gives the greatest possible contrast and shows no disposition to fog or veil, no matter how long a plate is left in the solution.

Metol is used because it brings into the negative a wealth of detail and in the strength here recommended, shows no disposition to fog a plate.

Sodium sulphite C. P. dry is used in the solution simply to impart a black stain to the silver molecule; as negatives developed without this reagent show the characteristic aniline stain from each agent used, but by using sodium sulphite we obtain a brown black deposit of very fine grain, giving good printing density.

Sodium sulphite is one of the most delicate salts used in photographic chemistry; if exposed to the air for a few minutes it is oxidized to sodium sulphate, and a few grains of sodium sulphate will reduce bromide of silver not polarized by light to metallic silver, causing a veil or fog to cover the plate. This salt should always be purchased from a reliable maker, in original bottles, and, if possible, the entire contents used when it is opened.

Meta bi-sulphite of potassium is used only to preserve the developer and prevent the action of the oxygen of the air upon the solution.

Potassium carbonate is not required in a developing solution and is usually harmful, as its function is to save time only, by rendering the gelatine soft or soluble, according to the amount used. If the carbonate is used in too great a strength we will note a loss of sharpness to our lines; they are no longer clear and distinct. The gelatine having become so soft has changed its position upon the plate and relation is lost.

Let us consider the factor of the temperature for a few minutes before closing this paper, as it is probably the reason why more failures are recorded than successes by amateurs in this line.

We find photographic chemistry depends upon sharply defined limits in order to produce perfect results. And these limits are from 60 to 75 F. At a lower temperature we will get a coarser and more contrasty deposit, with less development of tones, requiring more time to complete the development, and as we approach the maximum limits we gradually pass through a shifting phenomena of tones, until we get a soft negative with a wealth of detail, making negatives suitable for skiagraphic stereography. If we increase the temperature higher we find that considerable silver bromide is reduced, not polarized, by light; and at about 80 F. we begin to lose sharpness by the shifting of the soft gelatine, and by increasing the temperature to 90 F. we have a negative so flat and thin, but full of wealth of detail, that it is impossible to use it for any practical purpose. This is due to the solution of the gelatine, from the increased temperature and the alkali in the developer.

Analin derivative developers are capable of being mixed in various proportions as desired and may be used repeatedly if they are carefully saved in a close-stoppered bottle, and while they work slower each time, the resulting deposit is more beautiful.

It should not be necessary to impress upon all amateurs that all solutions used for developers should be filtered before using, as a crystal free in the solution will intensify its action locally, making streaks or spots as it is moved back and forth or by coming to rest for a minute.

Developers should not be exposed to air while not in use, or a slow and gradual decomposition will take place, which is told by the brownish color of the solution.

Amateurs will get better results by developing the plate in the dark and not looking at it every few minutes to see if it is carried far enough, as with this solution I have given the time element alone is important when sufficient exposure has been given.

A hand will develop in fifteen minutes, while a hip joint may require one hour. With the exception of skiagraphs of the hand and chest it is rare to get one with two much contrast. so that the fear of over-development may be neglected.

Success in photography means absolute cleanliness of hands, trays and solution. It means the absolute precision in weights, as well as pure chemicals.

DISCUSSION.

DR. MIHRAN K. KASSABIAN: The subject has been discussed so thoroughly by the essayist that very little remains for me to add to the chemistry and quality of the several developers mentioned. It is very difficult to choose a developer that is entirely satisfactory for X-ray work. There are so many factors entering into the selection of a developer that we are liable to fall into error. All of us have laughed at the amateur who is constantly changing his plates, and also the developer, and whenever a new one appears on the market it is adopted and the old one discarded, with the expectation that it will do all the work for him.

Before I had the opportunity of studying medicine I was a professional photographer, and then learned that if the operator will adopt one developer and learn to recognize its advantages and its disadvantages, he will eventually be able to do very good work simply by modifying it to meet the indications. Depending upon what the skiagrapher is developing, whether it be a hip, a hand, or something else, he can modify the reducer or the alkine agent as needs may indicate. Time exposures are naturally developed differently from instantaneous exposures, and the developer must, therefore, of necessity be modified accordingly. After all, the principal factors concerned in developing an exposed plate are experience and good judgment, and last, but not least, a thorough acquaintance with the developer.

Contrast is best obtained by developing the plates slowly and then intensifying them. It is very unlike the ordinary photography, where we are able to obtain all the contrast wanted. If the plate is developed slowly, and then intensified with a solution of bi-chloride of mercury, the detail brought out in this way will be all that can be desired.

It is essential for the examiner to know the proper or correct time of exposure, in order that the developer may work

properly and give the desired results. Here is where most of our trouble originates, in that we are not able to get exact time of exposure. The ordinary photographer can be more readily correct in this respect than we in our X-ray work. Knowing this, the developer can be modified by diluting so that we can control the process of the development to a large degree. I believe that the majority of developers would be good if the reducing and alkine agents were proportioned, so that they were suitable for the time of exposure. Personal experience and good judgment are essentials which will tell you as soon as you transfer the exposed plate into the tray whether it is "over," "under" or "properly" exposed. I keep the reducer and the alkali in separate bottles, and in other bottles I have the distilled water and bromide. A satisfactory development calls for a knowledge of the temperature of the room and also the quality of the plate being developed. As soon as the plate is placed in the tray you will know whether it will develop slowly or rapidly, and, accordingly, you will have to add some of the reducing agent or the alkali.

Of course, the duration of the development has a great deal to do with the production of a "good" negative. The tendency of the beginner is to remove the plate from the reducing agent and put it into the hypo as soon as the picture begins to "come out," causing a solution of emulsion. A film that has been "over-exposed" darkens soon after it has been placed in the usual strength of the developer, injurying it so that no print can be obtained. In developing X-ray plates we should proceed slowly, beginning with a weak developer, and, according to the requirements, increase the strength of the reducer or the duration of the development. I have noticed when a quick development is desired, operators place too much alkali into the solution, and the result is a "veiled" or "fogged" negative. This is especially true in skiagraphs of the hip or kidney. In the majority of cases I make it the rule to begin with a weak developer, then increase the strength prior to removing same, so that after fixation you will notice very fine details. Of course, the process of developing depends largely upon whether you are hunting a renal calculus or whether you want to get the shadow of the kidney or that of

an abscess. For stone in the kidney you can develop as you please, but when it is a case of enlargement of the kidney or displacement of that organ, then you will require very soft details, with a less dense negative. If you carry the development a little further you lose the soft details, and if there is the presence of a stone, you get the shadow. So that the development depends on what you are after, and what you want to bring out in the negative. Physicians send their exposed plates to the photographer for development, and there is no result because the latter did not know what he was developing the plate for.

I do not develop any plate over twenty or twenty-five minutes during cold weather. In summer I place all my solutions on ice. Formerly I put ice directly into my solutions, but that interfered with the developing process and I never knew the exact strength of the developer.

I have not had any experience with the developers that require two or three hours. It is too long a process for me, because I want to develop hurriedly, in order that I may know in as short a time as possible just what there is on my plate.

Concerning pyro and metol, I have had some little experience with both. I have never been able to obtain the same detail with pyro as I have with metol. In my judgment, metol is far superior to pyro, although it, too, has some disadvantages. It irritates the skin, and I have known men who have nothing to do with the the X-ray—professional photographers—to have trouble with their hands as we have, thus proving that metol is a severe integumentary irritant. This is particularly the case when we use it in conjunction with the X-ray. Pyro possesses one advantage. In hip cases, where we desire good, clear and distinct shadows, so that we will get good prints, we should use pyro, as it gives us a "yellowish tinge," which is very desirable in order to have good prints. The print is very soft, viz., less contrast. I am convinced that if we know the exact time of exposure and also are conversant with the advantages and disadvantages of our developer, we can always expect to do good work.

Dr. Wm. H. Dieffenbach, New York City: We have experimented with a number of developers at the Metropolitan

Hospital in New York, and the one that has given us the best results, so far as detail is concerned, is a developer that was not mentioned by either Dr. Burdick or Dr. Kassabian, and while we are not entirely satisfied with it, yet we feel that after further experimentation it will do all we can expect of it. I refer to edinol. We buy it in a concentrated solution, which we dilute fifteen times. It is a very good developer in cases of fracture and also in tuberculosis of bone. We also used it in a case of aneurysm of the aorta, and the development of the blood vessels was excellent.

My personal experience with these various developers is not very great, but we have used metol and hydrochinon, but edinol has given us better satisfaction than any other developer.

PROF. A. W. GOODSPEED, Philadelphia: I have been guilty of the mistake (if it be a mistake) of using every new developer that is placed on the market, and I have had some rather unique experiences as a result of that habit. After I have used a lot of any one developer until I feel suspicious of its further utility, I pour it into a large bottle that I keep for the purpose, and in that way I get a mixture of a number of different developers. If I have a plate that I am particularly anxious not to lose, I often take some of the mixture out of this "slop jar," and I assure you that the result is usually a most happy one. Possibly this is due to the fact that in the mixture there must be present a portion of it of just the composition best suited for any plate, the receiver causing no bad effect. Further, very old plates are not always to be discarded.

Some time ago I sent down town for some plates. The man brought me a package of plates and the stamp on the package showed that the plates were five years old. I was very much annoyed because I had to have a plate and did not have time to send for another lot. So I determined to try one to test the quality. I placed it in my camera, exposed it out of the window for a moment and, on developing it, I found that it was a most perfect negative. All the plates in the package were of the same quality, so that the age of a plate does not always interfere with its quality, even though it may have

been in a black wrapper or envelope for five years. I tried to get some more plates like those, but, unfortunately, did not succeed.

DR. J. P. HETHERINGTON, Logansport, Ind.: I have the same experience with developers as that mentioned by Prof. Goodspeed. I, too, hate to throw away my developer for fear that the new one may not do the work. The developer that has given me the best results was about six months old.

DR. BURDICK (closing the discussion): Edinol is a salt of metol, and that is the reason I did not mention it in my paper. It is true that metol will irritate the skin of persons who are particularly susceptible to such irritation. I have used it for some time, but have never had the slightest difficulty with it on that score; perhaps, because I never put my hands in it.

Dr. Kassabian makes a compound developer; starting with a small amount of the oxidizing agent and increasing it as he goes along. He is an old-time photographer and, therefore, he can take more liberties with his developer than the amateur can. My plates never see daylight from the time that they are taken out of the box until they come out of the fixing bath. Neither do they see the red light, because most plates exposed to the red light are spoiled. The average dark-room light is not safe for more than thirty seconds. You can prove that very easily by exposing a plate to the red light for several minutes and then develop it. It is not safe to use Dr. Kassabian's method, because the plate will invariably be fogged or veiled from too much exposure to the red light.

If you will use the developer I recommend you will rarely ever see an overdeveloped plate, no matter whether you leave it in the developer for twenty-four minutes or twenty-four hours; neither will it fog and it will not be developed so far that you cannot make an excellent positive from it. I have experimented with it for a long time, and I know that the proportions are just right.

With regard to Dr. Goodspeed's statement as to using an old developer—I believe that to be true. All these developers are complex aniline derivatives (pyrogallic acid is the exception), and the little decomposition that takes place when

they are mixed indiscriminately in a slop jar will not deprive them of their usefulness. My developer can be used repeatedly, providing the atmosphere is not full of organic material. If the atmosphere is full of smoke and gases of various kinds, all these developers can be used only once or twice, at the most, because it takes too long to bring about complete reduction.

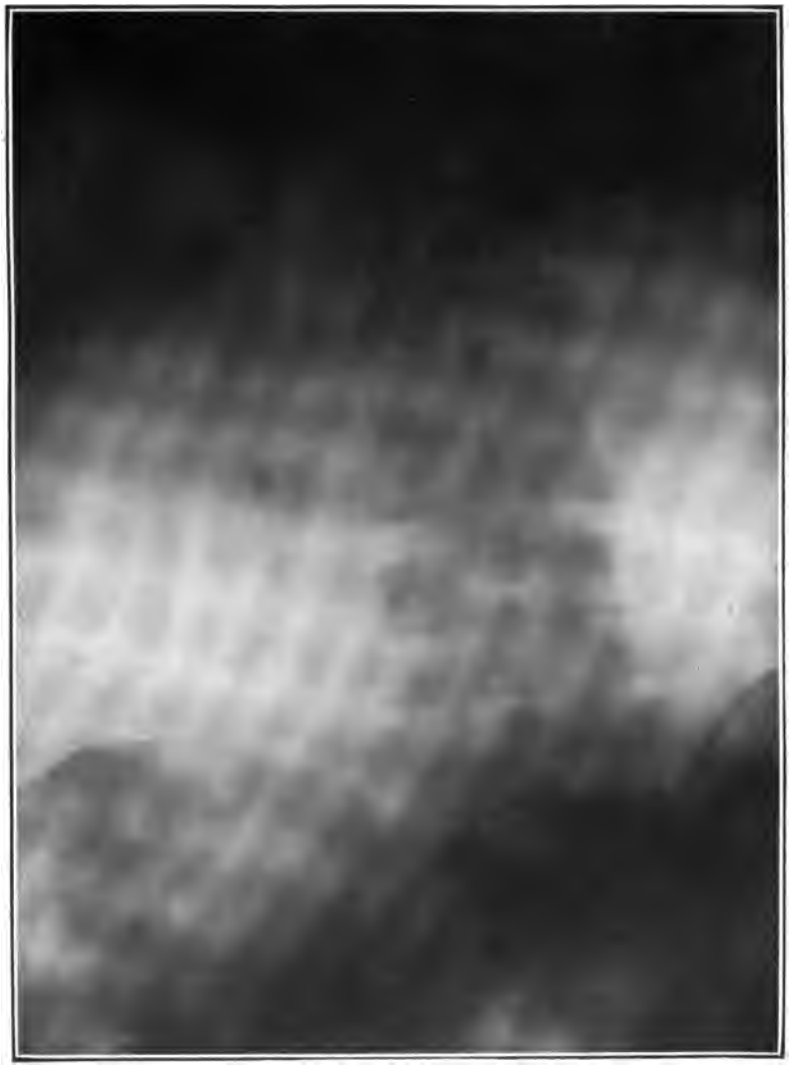
ACCURACY IN X-RAY DIAGNOSIS.

BY RUSSELL H. BOGGS.

Of Pittsburgh, Pa.

The field of radiography has not been exhausted. Much still remains to be done in perfecting and standardizing the technique, before the best results can be obtained. There can be no doubt that much improvement still awaits us, and the rapid rate at which the accuracy of X-ray work is progressing is surprising. The proper management of the work involves attention to a number of details, and the best methods are attained only by long and careful study. The rapid advancement of radio-therapeutic work has taken up a greater part of our time, and many details in radiography have been overlooked. In order to learn what details of technique produce the best results, a careful record should be kept, and when reports are made more of the minute process should be emphasized. Another great mistake is that much of the X-ray work is done in a hurried manner, and some operators are never able to produce two negatives of the same standard. This certainly shows that a careful study of the apparatus and technique has not been made.

Without having mastered the detail in the process, nothing but unsatisfactory results can be expected. The time has come for accuracy along this line of work as well as in other branches of science. Many cases in the past have been operated on unnecessarily, due to the lack of skill of some inexperienced radiographer. To-day when such a mistake occurs, it is not blamed on the fallacies of X-ray but on the operator, who makes a diagnosis without having a radiograph showing sufficient detail to give a decided opinion or without making a careful study of the plate. It is not necessary to cite a number of cases to illustrate the above statement, as I have no doubt each of you have had cases referred after they had been operated upon, in which a hasty diagnosis had been made from some poor negative. It is certainly essential that there should be a standard for a normal radiograph of



Kidney stone. Weight of patient, 145 lbs.; tube at a distance of 22 inches from the plate; 20 amperes going through the primary; a stone in the first part of the ureter; confirmed by operation.

every part of the body, and unless the plate reaches this standard no diagnosis should be made.

There are so many points which might be brought up, but I only want to mention one in regard to developing the properly exposed plate, and that is, the fact that so many operators seem to develop their plates in such a manner as to only obtain surface development. It seems to have been universally accepted that the rapid and slow emulsion plates are acted upon by the X-rays in about the same manner and degree, and that the best plate is the one which has a thick coating. It should also be understood that the silver in the emulsion is affected the same throughout the entire thickness according to the density between it and the focus tube, and that, as the density varies so greatly in the different parts, in order to affect the greatest amount of silver with the developer, the process must be necessarily slow. Then in order to obtain a slow developer, which gives sufficient contrast as well as detail and also leaves a clear negative, I have found that it is necessary to use one in which the reducer is at least twice as strong as the usual formula, with about one-fifth of the amount of alkali.

I have used many different developers, but cannot see any great advantage one has over the other. The following gives very good results:

Edinol	1 dram
Sodium Sulphite (dry)	10 drams
Sodium Carbonate (dry)	2 drams
Water	10 ozs.

With such a developer the image will appear slowly, the high lights, half tones, and shadows appear by degrees, and as the development proceeds it is often necessary to add more alkali, but this depends upon the exposure. When developing it must be borne in mind we have a plate, which, according to the density of the part, is over exposed, normally exposed, and under exposed. These conditions are always found in X-ray work, and, therefore, the development is an entirely different process, and ordinarily cannot be successfully done by a photographer.

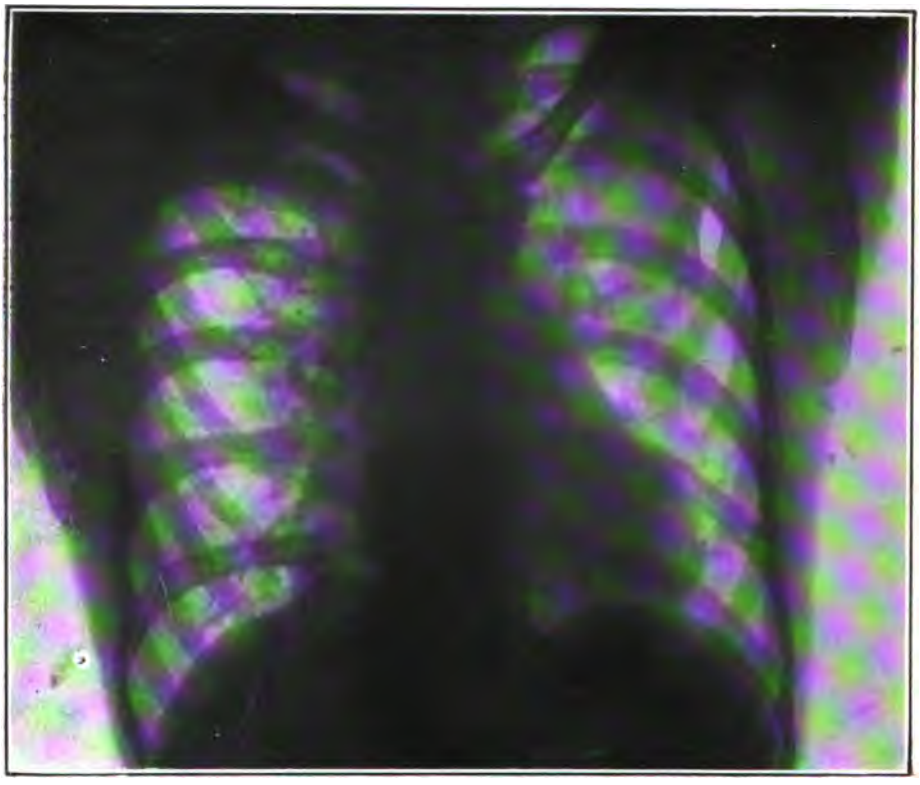
A physician cannot make a diagnosis until he is familiar with a normal radiograph of the part at different ages. He must

be familiar with the shadows cast by the normal parts in different positions, and then he will at once see whether the picture is a distorted or correct view of the part under examination. To-day, when the radiographer shows that a foreign body is present, he has done very little to assist the surgeon unless he is able to accurately locate its depth. Exact location of a foreign body in the tissues is done by a mathematical process, and is, therefore, accurate if the process is carried out properly. There are a number of processes, but each require the making of two radiographs with the tube in different positions.

Different operators use different methods and each, being familiar with his process, arrives at the same accurate location. I have had a radiographic table made with a modified Mackenzie-Davidson localizer attached which is so arranged that it is very easy to figure out the calculations quickly.

In a normal radiograph of the chest, the first thing you will see is the three vertical zones—one light in the center, caused by the heart and mediastinal contents, and two dark, one on each side of the light area, caused by the lung tissue being less dense. The pulmonary zones are crossed by the ribs, and in many radiographs the structure of the bone can be seen. On close examination usually the smaller bronchi are visible. In all radiographs which are taken during an inspiration the diaphragm and upper border of the liver are shown. In examining the lungs it is best to make two radiographs, one anteriorly, the other posteriorly, and when examining the heart and mediastinal contents not only anterior and posterior pictures are necessary, but also a radiograph with the tube placed at an angle to the mediastinal contents, and in this way a shadow of a diseased gland may be obtained, which would otherwise be obstructed by the vertebræ. When examining the developed plate, notice the position of the shoulder joints, compare the clavicles and ribs, and notice if the curve of the diaphragm is normal.

Then examine the respiratory and circulatory organs. Notice the degree of clearness of the pulmonary images and do not mistake a sclerosis of a bronchial tube for a consolidation, as has often been done. Another mistake which occurs frequently in examining a solidified lung is in diagnosticating a small amount of the normal lung tissue, which is surrounded by the solidification



Lung infiltration, showing division of bronchial tubes. Exposure, five seconds.

as a cavity. Cavities in the lung, no matter how small or whether filled with air or pus, can be shown and the depth located by the making of two radiographs with the tube in different positions, in the same manner as locating a foreign body. If the lung tissue is slightly œdematous, it is a much more difficult task to obtain a radiograph in a short exposure.

Finally comes the examination of the heart and the aortic arch. The position and size of the heart should be carefully noted, as it may be displaced upward by distention of the stomach, or laterally by fluid or a growth in the pleural cavity. One of the most important uses of X-ray in the chest is for the diagnosis of aneurysm. It not only diagnosticates the aneurysm, but shows whether it is sacculated or fusiform and, thereby, greatly aids in deciding upon the treatment. In the following case, which I reported in an article published in the *Journal of Advanced Therapeutics,* October, 1902, there had been a diagnosis of aneurysm made and the picture was taken to ascertain whether it was fusiform or sacculated. The question was if it was sacculated, the surgeon, Dr. McGrew, intended to place needles in the sac. The radiograph showed the aneurysm to be fusiform, with a certain amount of fibrin deposits in the sac. The patient had been to Johns Hopkins, and there had taken the gelatin treatment. It would have been extremely interesting to have had a radiograph before the gelatin treatment was given.

Another case was examined by X-ray to ascertain whether there was an abdominal aortic aneurysm, as had been previously diagnosticated. The radiograph showed all the necessary detail, but no unusual densities that would indicate the presence of an aneurysm. The picture showed the heart to be of enormous size. After close study of the radiograph and careful examination of the patient, a diagnosis of a complicated valvular disease was made.

A third case referred by Dr. E. Haworth for an X-ray examination with the following history: The case was one diagnosticated as aneurysm of the arch of the aorta by physicians of considerable ability and prominence, and was under treatment for the same for about two years. The first and most prominent symptom was interference with return circulation from the head and upper extremities. The lateral circulation from these regions was accomplished through the superficial veins of the chest

and abdomen which became much enlarged, forming a pronounced caput medusa. The circulation passed through these enlarged veins from above downward. The return circulation, therefore, from the head and upper extremities passed down through these veins and emptied into the femoral veins; thence, to the inferior ascending vena cava. The other characteristic symptoms of aortic aneurysm were not marked. Serum accumulated in the right pleural cavity as a result of the interference with the circulation, and was aspirated a number of times only to reaccumulate. The radiographic examination was made after the last withdrawal of the fluid. The radiograph showed the trouble to be a mediastinal growth with fibrous deposits in both lungs, but more deposits in the right. The differential diagnosis between aneurysm and a mediastinal growth was made from the following considerations:

1st. That the picture showed the growth was slightly irregular, while, if it was an aneurysm, the circumference would be more regular like the outer border of the heart as seen in a radiograph.

2nd. That the entire mass was not of the same density.

3rd. That there was a certain amount of fibrous deposit in the lungs.

4th. That under a fluoroscopic examination the growth did not pulsate.

While speaking of chest examinations, I will mention a case in which a child swallowed a nickel four months before coming for an examination. There is nothing of unusual interest connected with this case except that the nickel had remained in the œsophagus all this time, but lately the child's condition indicated that an ulcer had formed. During this time the child had been treated for acute indigestion.

Unless a radiograph of the head shows the inner and outer table of the skull, spheno-maxillary, vomer and nasal bones, the antrum of Highmore, frontal sinus, and all detail, of what use is the picture in the way of diagnosis? But with a perfect plate many cases of brain tumors, all foreign bodies, fractures, abscesses, etc., can be diagnosed.

Recently I had the pleasure of hearing a very interesting talk by a prominent nerve specialist on the diagnosis and treat-

Safety Pin in Oesophagus. Also showing outline of stomach.

ment of brain cysts and tumors. During his discussion, he said there were usually sufficient symptoms present in these cases to make a diagnosis, but that, after a diagnosis of brain tumor or cyst has been made, it was extremely difficult to accurately locate the growth. He never mentioned X-ray as an aid in diagnosis. This shows that X-ray has not received his serious consideration, or else his work has been done in a very unsatisfactory manner. In many cases of brain tumors and all cysts, there is sufficient density to both diagnosticate and locate the trouble.

The speaker, just referred to, said that he had made a diagnosis of 137 brain tumors and cysts, had advised operation in 30 of these and that 24 had been operated upon. The tumor was found in 14 cases and in 10 the growth was not revealed until the post-mortem examination had been made. Now if the X-ray had been used in these cases, the exact location might have been known before the operation, and probably in some few cases the picture would have shown whether an operation was advisable. I do not mention the above for the purpose of criticising the doctor, as his address was extremely interesting and instructive.

The want of contrast between the abdominal contents is the principal reason why radiography is more difficult here than in other parts of the body. In order to show the contrast between portions of the alimentary canal and the surrounding tissue, it is often necessary to introduce into the cavity a gaseous or opaque substance.

The stomach can often be distended in this way with the two solutions of sedlitz powder sufficiently to obtain a clear outline on the plate. It not only permits the study of the walls of the stomach, which may assist in revealing a tumor, but it especially facilitates the examination of the neighboring organs. The filling of these organs by an emulsion of bismuth can often be utilized to show the outline with more accuracy. In this way the path of a fistula can be ascertained by filling it with fluid.

A plate that shows the spinal column, with each articulation and process, and the outline of the last ribs, psoas muscles and, in most cases, the outline of the kidneys, should be a standard for making a diagnosis of pus, stone, or tuberculous deposits in the kidney, ureters or bladder, and tubercular or lympo-sarcomatous nodules in the intestines or omentum. It might be well to state

that a tuberculosis or lympho-sarcomatous condition of the above has been mistaken in several instances for renal calculi, probably also in some cases, where the radiograph indicates the presence of a stone the surgeon has been unable to find, the shadow being due to some density in the intestines or omentum.

If such were suspected, two radiographs should be made with the tube in different positions, as in locating a bullet, which would show the depth of the object casting the shadow. I have four radiographs, two showing tuberculous deposits in the kidney, one a tuberculous deposit in the bladder, and one lympho-sarcomatous nodules of the bladder. One of the radiographs of the kidney and one showing the tuberculous deposits in the bladder, were of the same patient. When the patient was referred to the surgeon, he found during the examination bacilli were present in the sputum in large numbers. The diagnosis was made of tuberculous deposits and the patient was sent South. The other tuberculous kidney was removed on the strength of the radiograph without opening the kidney to prevent infection. The eight calcareous deposits which were diagnosticated as renal calculi were found when the organ was examined.

The fourth case showing calcareous deposits caused by lympho-sarcoma was referred for an examination on account of his symptoms which simulated stone in the bladder. Two radiographs were taken, one with the patient lying on his face and the other on his back, the plates being under him during the exposures. Both radiographs showed three spots, and a diagnosis of incysted vesical calculi was made. A week later the surgeon operated without having the plates present and failed to locate the suspected calculi. Then there were a great many things said about the fallicies of X-ray. Later Dr. C. B. King was called in to see the case, and made a diagnosis of sarcoma of the liver and adjacent organs. The patient died and a post-mortem examination was held. The examination showed sarcoma of the gall bladder and pancreas. In the omentum there was a number of calcareous deposits, and in the bladder the three calcareous deposits, which showed in both the radiographs, were found. All present were much impressed with the accuracy of X-ray diagnosis of different densities.

Among the cases of kidney stones which I have located since I read my paper on calculi, with a report of cases a year ago, I have two of unusual interest, one on account of the patient weighing two hundred and forty pounds, this picture showing three large stones and also the outline of the kidney, and the other on account of the large amount of pus as well as of a stone present. Both cases were verified by operation.

Mr. H., aged sixty-five years, referred by Dr. R. J. McCready, had hæmaturia and some pain, the bladder symptoms gradually increasing until there was a stoppage of urine, and the pain on micturition increased until September first, when the case was referred for an X-ray examination.

The plate showed a growth in the bladder which was diagnosticated as carcinoma. Several days later the case was operated on and the diagnosis was verified.

Among my collection of hip cases I have one of unusual interest which I will mention.

Mr. C., referred by Dr. Nettleton, had been treated by several other physicians for rheumatism. The radiograph showed that the trouble was tuberculosis, that the head of the femur was absent, and that the femur, when a weight was placed on the limb, was displaced upward to the crest of the ilium, and that this displacement had infected the border of the ilium.

DISCUSSION.

DR. GEO. E. PFAHLER, Philadelphia: I would like to emphasize the importance of using the X-ray in making a diagnosis of brain lesions. I would not want my skull opened on the strength of a skiagraphic examination, but that operation is of such a serious character that no method of diagnosis should be neglected. I have shown conclusively that all varieties of brain tumors can be shown by the X-ray, and that they can be shown in different parts of the brain, or, in other words, in the location in which tumors are most likely to occur. I succeeded in showing a gumma of the brain one-half inch in thickness at its fixed part, two and a half inches in length and one and a half inches in width. I stated that it was irregular in outline, broader at one end than at the other and gave its exact location. It was removed by Dr.

Heam in the presence of a number of our neurologists and Dr. Mills, and showed that the description I gave was absolutely correct.

I have also succeeded in showing softening of the brain. Therefore, in making a diagnosis of tumors of the brain or softening the X-ray should always be brought into play.

DR. MIHRAN K. KASSABIAN, Philadelphia: I would like to mention what I consider an important advantage when skiagraphing tumors of the brain. I have learned by experience that the entire skull should be shaved prior to skiagraphing. I once skiagraphed the head of a lady who had an abundance of hair, and unfortunately more on one side than on the other, and upon examination of the plate thereafter I observed some very peculiar and suspicious shadows. I prevailed on her to have her head shaved and when I examined the second plate I failed to find anything at all, hence I was convinced that the shadows seen on the first plate were spurious and caused by the wealth of hair.

About two years ago I had the privilege of raying a case for Dr. Savary F. Pearce of Philadelphia. I made a diagnosis of either a tumor or a cyst in the motor area. These two conditions are not differentiable very easily by our methods of examination. The patient died before the operation was performed, and at the post-mortem my diagnosis was confirmed.

We must be very careful when skiagraphing tumors in certain areas of the brain, especially when they are located in the occipital region where the shadows are ofttimes most confusing.

DR. WM. C. EGELHOFF, Chicago: I wish to confirm the statement made by Dr. Kassabian in regard to the taking of pictures of the head, but differ with Dr. Pfahler. I think we should always use the X-ray to localize conditions of the head. With correct manipulation we can show a great deal in the line of foreign bodies, tumors, cysts and other brain lesions. I had the pleasure of diagnosing a case that had passed through the surgical, medical and neurological staff without being diagnosed. The case was that of a young man of twenty-five who had from three to five epileptic seizures a day. The cause was obscure and the case finally was referred to me for diagnosis with the X-ray. I made two skiagraphs, exposing one a little longer than the other. I ex-

posed two plates so as to be certain in my diagnosis because with one plate we are liable to be misled, for the plate may be defective, may have a chemical stain. I found an abscess in the fore part of the head pressing on the frontal lobe. It was very sharp in outline and the diagnosis of cerebral abscess was made.

The case was referred back to the surgeons for operation. The skull was trephined at the point where I found the abscess, and my diagnosis was confirmed. The symptoms subsided promptly and the patient made an uneventful recovery.

COLLAPSING TUBES.

BY HENRY K. PANCOAST, M.D.,

Of Philadelphia.

I wish to relate two cases of spontaneously collapsing X-ray tubes, in either of which there might have been serious results, and compare them with an accidental collapse of another tube, in which serious results did occur. Such accidents are usually not a menace to the operator, but may some times cause severe injury to the patient, especially when a skiagraph is being made near the head, or when treatments are being given in this region.

A little over a year ago, while carrying a Queen self-regulating tube through the corridor of the University Hospital, the tube suddenly collapsed in my hand from no apparent cause. I was holding it by the cathode extremity, close up to the bulb, but was not touching the latter. This was during the warmest summer weather, and the tube had been used but once. There were a few slight scratches on my hand and forearm, and the physician walking at my side received a few slight cuts on the right side of his face. He was not near enough to have in any way touched the tube and assured me that he could see no cause for the "explosion." The hospital engineer, who was walking directly behind us, confirmed these facts.

About one month later, while holding the same kind of a tube in much the same manner, in order to examine the anode, to observe the amount of destruction of the platinum at the focal point, the tube collapsed in my face. Fortunately, I had on my glasses, and, except a few slight scratches about the face, no harm was done.

About the middle of September, while removing a Swett and Lewis tube from a closet near an open window, a sudden gust of wind blew the door against the tube, before it could be drawn out of the way, and resulted in a collapse. Several

pieces of glass flew into my eyes. Of course, the fragments were very small, as these collapsing tubes usually have their glass almost pulverized. I thought I had removed all the fragments from each eye, but on the following day the left eye was very painful, and examination showed one piece of glass just within the center of the cornea, and another one that had penetrated almost into the anterior chamber. The fragments were removed, but the eye was disabled for nearly three weeks. This latter accident had a discernable cause, but it goes to show what might happen during a spontaneous collapse. The wires might fall on the patient, or he might have his eyes injured seriously, or might become startled and jump up and be hurt by the current. I cannot see any particular couse for the spontaneous collapse of tubes, but I know that such accidents are by no means uncommon, having spoken to a number of men who have had similar experiences. Probably there is insufficient care taken in annealing the glass. Some varieties of tubes will not collapse, while others will, but now I never handle any of them without having on my glasses. Some precaution should be taken in the manufacture of these dangerous tubes, and their makers should have their attention called to this defect. Moreover, all tubes should be surrounded by a screen or box of some sort, both for the protection of the operator and the patient.

DISCUSSION.

PROF. A. W. GOODSPEED, Philadelphia: Dr. Pancoast spoke of being very cautious about some tubes, while others he did not fear. I am sure that it would be valuable for us to know what class of tube that was.

DR. PANCOAST: The two tubes that exploded spontaneously were Queen's self-regulating tubes, and those are the tubes that I am told have exploded in the hands of other operators.

PROF. GOODSPEED: That certainly is a point worth knowing.

DR. HOLDING: I have the same experience with that make of tube, but I was operating the tube very lightly.

DR. CUSTER: I believe that an X-ray tube may collapse, but it never explodes. I have always considered that such an ac-

cident might occur at any time, and I have constructed a screen, so as to protect my patient. Since I have been using the screen I have not had any tubes collapse, but I continue to use the screen, so as to be prepared in case of accident.

DR. WM. C. EGELHOFF, Chicago: I was unfortunate enough to have a similar experience, and with the same make of tube. My tube had been used for some time, however. I turned on a very light current, when a piece dropped out of the tube without any further collapse of the tube. I have also had the same experience with other tubes of the same make. Those that were struck accidentally would collapse at once with a loud report. One tube was punctured, because the wire was a little too close to the tube. Another one was punctured by the loosening of the anode.

MR. MARTIN WILBERT, Philadelphia: This collapsing of tubes is a very serious problem, but I believe that it does not occur as often now as it did several years ago. I had a Queen tube collapse in our laboratory, but it was a new tube. I do not know whether Dr. Pancoast's tubes were all new. I think the manufacturers of the particular tube that he referred to are not well up on glass blowing. They are not manufacturers of glass, and I know that they do not anneal the tube at all. That same tube, however, after being used a while, after it has been heated up several times, will last almost indefinitely. We have one tube of that make that has been in use, off and on, for about six years, and daily for the last sixteen months.

I think that all these tubes, after heing heated up several times, will stand the ordinary usage as well as any other tube. But when they are new, and if you are not very careful, they will collapse from sudden changes in the temperature. The particular tube that Dr. Pancoast spoke about he probably was holding near the thin part of the glass, and the heat of his hand warmed it up sufficiently so that it collapsed.

PROF. A. W. GOODSPEED: A tube as delicate as that should not be used at all. The temperature of the hand should not cause a tube to collapse. I would like to know whether it was a new tube.

DR. PANCOAST: The first tube was a new one. It had been used but once. I do not know just how long the second tube had been in the hospital, but it was not for long.

PROF. GOODSPEED: I ought to say in justification of the tube that I have used that make ever since they were put on the market, and I have never had any accident yet. I never heard of a collapsing tube until about six months ago, and I am very much interested in the matter.

DR. CHAS. L. LEONARD, Philadelphia: I have been using the Queen tube since it was first constructed, but have never seen one collapse. I have one at the present time of that make that I consider a peculiar physical phenomenon. It has made my calculus plates since last January, and has on its anode end a crack which completely encircles the stem, and yet the regulator works to perfection. I have made a number of skiagraphs; in fact, some of those in the exhibit were made with that tube.

PROF. GOODSPEED: It is possible that while we are holding the tube that it may strike our body or clothing without our knowledge, and then collapse. It really does not require a blow of any great force to cause this accident.

DR. KASSABIAN: I have been using a Queen tube since I have been doing X-ray work, and never had any experience of this kind. I believe that Prof. Goodspeed has pointed out a very plausible solution of the difficulty, that the tube strikes against our clothing without our knowledge.

DR. GEO. G. HOPKINS, Brooklyn, N. Y.: I rise to a point of physics. Our tubes are all constructed with a vacuum, as subjected to a pressure of fifteen pounds to the square inch, and how a vacuum tube can explode is a mystery to me. The tube collapses. It is unfortunate to get on wrong ground in discussing these things. Of course, we get force in the suction, and that drives the fragments of glass in the direction opposite to that in which the tube collapses. If the tube exploded, ours would be the most dangerous occupation in the world. I have had three tubes collapse, but none of them was a Queen tube. I do not like the Queen tube at all. I have tried it, but am not pleased with it.

PROF. GOODSPEED: I would also like to rise on a point of physics on suction. We have no such force as suction. I would also like to ask Dr. Egelhoff about the piece that "fell out."

DR. EGELHOFF: I think that was a case of explosion. The piece actually fell out of the globe, a piece about the size of a silver dollar, and of irregular shape. It dropped out with a report, and the first thing I saw was the spark passing through the opening.

In regard to the others—those were accidental cases. One tube collapsed within eight inches of my body. While passing a chair, it struck the tube. The pieces of glass were scattered all over the room, although I was not hurt in any way. Another tube broke because of the stand falling.

PROF. GOODSPEED: The tube may have been punctured before, so that the air leaked in and the stream, as it passed from the two electrodes, probably produced an explosion of the air, and the tube gave way at its weakest point.

DR. EGELHOFF: The tube lit up properly before that with an ordinary light for just a few seconds, and then the piece dropped out and the spark passed through the opening.

DR. HOPKINS: I want to ask the chairman how his tubes are made, because he objected to the use of the word suction.

PROF. GOODSPEED: The air is pumped out of the tube, but there is no suction.

DR. W. W. JOHNSON: This matter of collapsing tubes has been discussed several times. It is possible that there may be a little projection of glass, and the least little break starts it, because there is a tremendous tension in the tube.

DR. WM. S. NEWCOMET, Philadelphia: I do not wish to condemn the Queen tube, because I practically use them altogether, usually from four to six hours every day, and that speaks well for them. However, several have collapsed from some cause unknown to me. One experience last spring with a collapsing tube was rather startling. Just as I was placing the sheet lead over the patient's face, to treat a sarcoma of the antrum, there was a loud noise behind me, and I had a sensation, as if a person had thrown a handfull of sand against the side of my face. The tube had collapsed. I was about two

feet away from the stand that held the tube. It had been in use about fifteen minutes before, and presume it had been in use for about three months. The room was warm and no draft seemed possible. No particular attention was given to atmospheric conditions. I believe that this accident is likely to occur to any make of tube; in fact, you simply have to refer to the journals, besides I know several instances that have not been reported. I believe that in the future we will protect our tubes so as to avoid serious injury, both to ourselves and to our patients, but, so far, most of these devices for this purpose are rather cumbersome. In this particular case, no doubt, the patient would have been blinded if the tube had collapsed a little sooner than it did.

When one considers the mechanical construction of this very frail piece of apparatus, it is wonderful they stand the severe trials to which they are subjected. All these tubes must necessarily be of very thin glass, and the expansion and contraction of the glass and the metal parts is very irregular. The glass that stands heat best is the lead glass; unfortunately that is not the best glass for the X-ray, and it is surprising that the ordinary flint glass stands the heat to which our tubes are subjected at times as well as it does.

DANGER OF THE X-RAY OPERATION.

BY JOHN T. PITKIN, M.D.

When, for the first time, one beholds an X-ray tube in operation, the mild green or yellowish color of its active hemisphere, the blood red or orange color of the inactive hemisphere, which can be obtained with strong condenser discharges; the ruby redness of the target, or the light blue color of the cathode stream; a blue cloud, hovering behind the target; the green, circular, aurora borealis, or green, scintillating, radial, aurora australis; the bright green, dancing spots of the cathode splash; the circular green zone of the tube reversed; the bluish twinkle of its fading light; the slower dying out of the incandescence of the target and the target's own modicum of ordinary light; the ever-changing, ever-expanding circle of colors on the cathode cup; the bluish marking of the tube which has seen much service—perchance, the pyrotechnoidal display of the punctured tube—he is liable to exclaim, "How beautiful!"

As he observes the delineation of bones, viscera or foreign bodies upon the fluorescent screen or photographic plate, its curative power in skin affections, painful disorders, cancerous, tubecular and other malignant diseases, he will, in all probability say, "How marvelous!"

Should he strive to fathom its physics, its modus operandi, ask himself of what form of matter the cathode and the anode streams consist? Whether, in the working of the tube, there is transmutation of matter from one elementary form into others, or of matter into energy?

All of the colors of the rainbow, depicted on the concavity of the cathode cup (the cathodal spectrum), how are they formed? From whence came they? Of what composed?

Are there separate and distinct rays emitted from the tube that cause burning, others fluorescence, and, still others, photographic effects? Or do the same rays produce all of

these phenomena? In other words, are these rays homogeneous or, like the rays inside of the Crook's tube, heterogeneous?

What rays possess the healing powers?

Where and how does the X-ray have its birth? Of what does it actually consist?

1. If in the old form of Crook's tube, without a target, the X-light is generated in the glass wall of the tube, wherever it is subjected to bombardment, and, if at the place of bombardment, heat and a green fluorescence always accompanies the generation of the X-light; and if in the form of tube now employed, a portion of the cathode stream passes by the target, or if the target is displaced, and the entire stream passes by and generates X-light likewise by the bombardment of the glass wall of the positive end of the tube, accompanied by the green fluorescence (which, on account of its position and shape, I have christened the aurora borealis of the X-ray tube), with the usual modicum of heat, then does it not follow as a corollary that wherever there is a green fluorescence of the glass wall of the tube, with the production of heat, there the X-rays are always generated, and the glass wall's surface is the seat of molecular bombardment?

2. If the rays of Rœntgen have their birth at the target, why do they not shine through that structure, as they do through the glass wall that is subjected to bombardment?

Can the target reflect rays that are not reflectable, refractable or defractable?

3. Why are the afferent target rays convergent; the efferent rays divergent (leaving out of consideration the effects of the manner of their respective construction), unless the former partake of the character of the negative, the latter of the positive, electrical brush discharge?*

4. If there is not an anodal stream, how shall we account for the bluish marking of the glass wall of the active hemisphere, which is proportionate to the amount of service a given tube has seen?†

*The word atoms, or corpuscles, or electrons can be substituted for molecules according to the fancy or belief of the reader.

†How shall we account for the green flourescence and the thermal effects?

5. If the X-light is not generated in the glass wall, why does its volume increase with the size of the tube employed, and, consequently, the extent of the glass surface exposed to the anodal influence, while the size of the target is relatively unimportant?

6. If the X-light is generated both at the target and in the glass wall, would not the photographic plate show a double picture?

7. If it is the X-ray that causes the glass wall of the tube to fluorescence with a green color, why does it not cause the same phenomenon in a piece of glass held in any portion of the X-ray field?

Does the fact that a portion of the rays in a vacuum tube, either cathodal or anodal, can be diverted from their course by a magnet, while another portion of the same streams cannot be so deflected, as shown by Thompson, prove that the latter are the rays of Rœntgen?

Are infinitesimal particles of glass or other forms of matter projected from the tube into the X-ray field? (Nichola Tesla was one of the first to advance the hypothesis that matter was thrown from the tube outwards into space.)

If not, why is the X-ray inflammation of the skin nearly always upon the side of the parts presented toward the apparatus?*

Why does the clothing or a thin aluminium screen afford so much protection to the bodies of operators and patients?

The dermatitis may end abruptly where the clothing has covered the person.

Is there some unknown radio-active element, like radium, palonium, thorium, uranium and helium, in the glass wall of the tube—a hypothetical Rœntgenium, if you please—which

*Additional notes, taken at the Philadelphia meeting of The Rœntgen Ray Society. Dr. James P. Marsh, of Troy, N. Y., reported that the soles of his feet had been burned, their position, under the operating table, the doctor sitting near the patient. As a result of the condition of his feet, the doctor was obliged to be carried about by attendants. It was explained at this meeting that the dermatitis probably came from the reflected rays of Goodspeed.

Dr. Henry K. Pancoast stated that when a Crook's tube collapsed, a by-stander sometimes felt as if he was in a shower of small particles.

when subjected to bombardment, emits radiant energy or radiant matter?

1. If this is not the case, why should a new tube fluoresce, with a bright grass-green color, become duller, more like an olive green, then yellowish, which, in turn, fades with months and years of use?

2. Or, why should the radio-activity of an adjustable vacuum tube gradually decrease after a year or more of service, although the target glows with the usual amount of redness?

3. How shall we account for the bluish, greenish and yellowish tints (not pyro stains) sometimes seen in the developed negatives?

4. Why does the new examining screen follow somewhat the same change of colors as the X-ray tube?

Will the incorporation of radio-active elements in the glass wall of the tube multiply its present capacity and its therapeutic effects? If so, what a promising vista of future possibilities opens before the radiographer.

Why should an eight-inch tube, exhausted by use, recover by rest much more rapidly than a smaller tube?

Upon asking himself all these, and as many more equally pertinent questions they may suggest, he must invariably remark, "How profound!"

If he injudiciously ventures too near the excited tube, or remains in the weaker zones of the field too many days, months, perhaps years, and if, in consequence, he sustains X-ray inflammatory effects, with their complications and sequelæ, he is liable to ejaculate, "How infernal!"

For beautiful, marvelous, profound and infernal are the attributes of the X-ray tube.

It is with the last subdivision, or the untoward effects, of the X-ray upon the operator with which the present paper is principally concerned.

X-RAY INFORMATION.

This danger to the operator increases with—

1. Nearness to the tube (in a compound multiple ratio);
2. Number, frequency and duration of exposures;

3. Size, hardness and degree of excitement of tube;
4. Poor bodily condition;
5. An injury, blow or cut on parts slightly affected;
6. Number of previous attacks, each attack leaving him more vulnerable.

Conversely, the danger decreases with—

1. Distance from tube;
2. Infrequent and short exposures;
3. Softness of tube, provided it is under excited;
4. Interposition of substances—clothing, screens of copper plate, iron, tin, zinc, aluminum, glass plate, etc.—their density, thickness and other qualities as yet unknown;
5. Vigorous bodily condition;
6. A position behind the target and static machines, from whence rheostat and spark gaps can be operated.

THE RELATIVE DANGER OF DIFFERENT TYPES OF TUBES, AND HOW WE JUDGE BY THE APPEARANCE OF A TUBE THE DEGREE OF PENETRATION OF ITS RAYS WITHOUT THE EMPLOYMENT OF THE FLUOROSCOPE.

All other conditions being equal, a hard tube, or one in which the free concave surface of the cathode cup has a light blue, transparent, circular spot about the size of a silver dime, with a prismatic ring of colors at the outer border of the blue, the target whereof glows with a redness throughout its entire extent with a reddish white center, the glass wall of the active hemisphere covered with a translucent blue deposit, is the most dangerous, its rays most penetrating.

A medium tube, or one having a cathode cup, colored with a dark blue central spot, about the size of a five-cent silver piece, and having a target that glows with uniform redness, a blue cloud hovering behind the target, is less dangerous, its rays less penetrating.

A low tube, or one having a cathode cup, colored seal brown, of a golden hue; or a minute, blue-black central spot, with a red border to the blue, having a blue cathode stream and a green aurora borealis, *i. e.*, positive or northern green circles at the positive end, the stem of the same extremity hav-

ing a green color, is least dangerous, its rays least penetrating.

The classification of tubes into hard medium and soft is very general, because in practice we are using tubes of every degree of each sub-division, but it will answer our present purpose if I make special mention of the extremely high and extremely dangerous tubes that are hard to excite. Once started, they light up irregularly, accompanied with a crackling sound. They have small dancing green spots, formed by the splashing of a portion of the cathode stream against the wall. They also have a green aurora australis. The outside of such tubes becomes rapidly covered with dust and elementary carbon. They are enveloped in a strong, high tension, magnetic field, which electrically charges all objects in the neighborhood. Such tubes emit rays of an extreme degree of penetration. The relative danger of these tubes will change when we have stronger exciting apparatus. The latent capacity of the softer tubes has, probably, as yet never been utilized.

The length of spark a given tube can back up is not mentioned, because the solidity and thickness of a spark are more essential to the efficient operation of a tube than its length. At least, this has been my experience.

For purpose of study, let us divide the action of the rays of Rœntgen upon the operator into four arbitrary stages:

1. Preparatory stage, or stage of first impression.
2. Premonitory, or threatening, stage.
3. Stage of inflammation and disintegration.
4. Stage of chronic skin diseases, etc.

PREPARATORY STAGE OR STAGE OF FIRST IMPRESSIONS.

As you are well aware, the operator receives no warning from the tube; experiences no sensations while being injured. After a time there is a little change of color of his hands and face. This he may erroneously attribute to the action of the solar rays—

"His face is like the tan."

A few papules or pustules, with itching here and there, or bran-like scales, he attributes to a local skin trouble (prur-

igo, acne or pruritus); a little swelling of the hands and features to a circulatory disturbance; the falling out of his hair to senility; when, in reality, they are caused by the Rœntgen rays, which are rendering the integument more and more susceptible to their action. Such symptoms should be looked upon as harbingers of an impending storm.

During a long period of increasing susceptibility, the operator may imagine himself an X-ray immune, as if by some special dispensation he, like Shadrash, Meshach and Abednego, can walk in the fiery furnace (of the X-ray field) and not be burned.

PREMONITORY OR THREATENING STAGE.

The symptoms of this stage are: Itching, warmth, local diaphoresis, a mild seborrhoæ, partial anæsthesia, luxuriant or deciduous hair (in hirsute people, the shedding of the hair may be the first indication of the rays' effect), cutis anserina (goose skin), very small, shot-like bodies in the cuticle, a glossy appearance of the parts, as if they had been varnished; œdematous swelling of the sub-cutaneous cellular tissue, causing the hands and face to become puffy, as they do in Bright's disease, rendering the fingers and palm of the hand stiff and awkward, effacing anatomical markings, and giving a general rotundity of contour; punctate red spots, a few and scattered (discreet), or many, and close together (confluent), in groups, patches or diffuse, some raised, others on a level with the surface; they may cause the skin to become as rough as the surface of a nutmeg grater. Some of the minute elevations may be colorless; they can be seen by looking at the parts obliquely; they can also be discerned by careful palpation—there is a flushed look to the skin about them.

Discoloration of the Skin—Red, reddish-blue, yellow, brown or black. The first two colors may or may not disappear; the others always remain on pressure. Pigmented portions of the body are especially affected by pigmentation. The same is true of dark individuals. It is by keeping diseased parts of the patients who have malignant ailments in this stage of irritability, œdema, tanning or redness and partial anæsthesia, that

the greatest number of cures can be effected. From this stage the operator may recover, with or without desquamation. (Exclusion of all forms of actinic rays, a good sweating of the parts, and crowding all the other emunctories, will help to restore the parts.) Otherwise, as the result of further exposure, an operation, or an accident, such as a blow or cut, to the irritated parts, the process will slowly, insidiously merge into the stage of chronic inflammation, with its "cardinal signs, calor, dolor, ruber, tumor and functio lessæ."

STAGE OF INFLAMMATION AND DISINTEGRATION.

The pathognomic symptoms of X-ray inflammation, as experienced by myself, after seven years' exposure in the X-ray field, were extreme itching, with constant desire to rub, scratch or dig into the affected parts. If the itching of the alleged seven-years' itch could be crowded into a few months' time, it would not be more aggravating. Eruptions, scarlatina-form rash, miliary papules, pustules, and vesicles, came in successive crops. They resulted from the more or less destructive inflammatory involvement of the follicles, and their cellular elements, like thorns in the flesh, or other foreign bodies; they were thrown off, leaving the skin honeycombed with small ulcers oozing a hydro-serous discharge, alkaline in reaction. This discharge may be odorless or have a putrid smell, according to the severity of the process. Some of the hairs could be drawn from their pockets, as if they had been loosened by electrolisis.

Exfoliation of the Skin—Fifty, a hundred times or more, the epidermis was thrown off in scales of various size, shape and consistency. In places slightly affected the desquamation was scarlatina-form, the disease painless. Where quite severe, the scales were at first thick and macerated, pseudo-membranous. Late in the disease, the scales became desiccated and appeared as they do in many forms of skin disease. If the scales were torn away, the surface bled freely from the points of their attachment.

Inflammatory Mounds—Where the process is quite severe, but attacks circumscribed areas more severely than intervening

spaces, inflammatory mounds appear capped with a white membranous patch. In time the patch breaks down, leaving a ragged-edged crater-like opening. A common position for these mounds is over the articular surfaces, but they may form upon the dorsum of the hand, the fingers and in other localities.

Extensive Ulceration—If the inflammatory process is severe, the eruptions, small ulcers and mounds all become confluent, the surface breaks down, forming large ulcerated excavations with a raised border. Their central portion may be either naked or covered with a thick, whitish, pseudo-membrane. Under these conditions the suffering is intense, the discharge sanious and offensive.

Pain and Suffering—For a description of the pain and suffering, hyperæsthesia and paræsthesia, no language, sacred or profane, is adequate. The sting of the honey bees or the passage of a renal calculus, is painful enough, but are comparative pleasures, because, being paroxysmal, they have a time limitation. Extreme tenderness to the slightest touch; hot and cold waves and flashes; warmth, tingling, pricking, throbbing, stinging, crawling, boring and burning sensations, as if the parts were on fire and contained bugs and other living things; feelings as if the anatomical structures were being moved from one position to another—all of these sensations are proportionate to the depth of the inflammatory process.

All forms of radiant energy, light, heat, magnetism, ultraviolet rays, etc., increase the suffering. The parts are irritated by soap solutions or attempts to use them for any purpose. The suffering is also augmented if the affected members are allowed to become dependent, hence the afflicted operator holds his hands high above his head, even sleeping with them in that posture. If the inflammation in his hands is severe, muscular action will be temporarily lost, the fingers immobile. He must be dressed, undressed and fed by attendants.

Healing of the Parts—There are abortive efforts of the parts to heal. They heal over only to break down again, or, healing in some places, they break down in others. No healthy scabs form over the ulcers. No laudable pus, so called, appears.

The formation of granulations and scar flesh is defective, consequently the processes of repair are indolent, ineffectual, requiring months to restore the parts. The healing powers seem to be partially paralyzed, the disease intractable, recalcatrant.

Eventually the epithelial cells will spread from the margin and from islets over the ulcerations, and the injured parts are thus supplied with a thin investment. Muscular power returns. Wherever the hair is restored, as it frequently is, it will return more vigorous.

Physiological rest, an elevated position, exclusion from all forms of actinic rays, the burning away of deciduous material with dioxygen, the employment of formaldehyde (10% solution) as an antiseptic wash, and a thick dressing of equal parts of vaseline and powdered starch, evacuation of pustules and the wearing of kid gloves for several months after the acuteness of the attack has passed, will afford considerable relief to the sufferer. Dr. Robinson, of Philadelphia, uses picric acid; Dr. Duhring, of the same city, employs the lead plaster.

I quote the following, illustrating an extreme degree of chronicity of X- ray inflammation, also showing how the operators who work with the most powerful apparatus and the greatest number of hours per day are usually the greatest sufferers:

LONDON, Aug. 6, 1903.—(Via Associated Press.)—"Two doctors belonging to the London Hospital have been affected by X-rays in a manner similar to that of the assistant of Thomas A. Edison, and have been compelled to abandon their work. They were engaged for a long time in making examinations of and manipulating diseased parts while X-rays were directed on the patients.

"When they began to suffer they tried gloves on the back of which lead foil was sewn, but these impeded the movements of their hands, and were discarded.

"One of the operators ceased operating under the rays eighteen months ago, yet his hands have improved little, despite constant treatment."

To return to my own case, large red blotches and acne pustules appeared upon my face and neck, with a burning sen-

sation, followed in time by desquamation and restitution. The parts were left sensitive to light, heat, etc.; they for a time, caused them to redden and peel in furfuraceous scales. My left hand was much involved; hundreds of minute abscesses formed upon the dorsum. The integument exfoliated many times. The nail of the ring finger came off, but was renewed. The nails of all the digits, except the thumb, became deformed, brittle and deficient in their usual luster. The shape of the hand was permanently changed, the rugæ of the skin, the ridges on the nails, the knuckles and palmer arch are more prominent than they were formerly. Yawning caused muscular spasm of the fingers. Inflammatory mounds with their white caps and crater-like openings came and went in the usual dilatory manner.

Five months after the onset of the attack, the parts had healed, but were so sensitive to the Rœntgen rays that a fifteen seconds' exposure, about one yard from the tube, in a strong, high tension field, caused a secondary dermatitis. The period of incubation, usually from one to two weeks, was reduced to as many days. The secondary dermatitis cleared up several large, ugly patches of skin disease left from the primary attack. It is thus that the X-light may, in a measure, prove to be a remedy for its own indolent process and sequelæ.

Eight months after the onset of the primary attack, improvement slowly, but surely, continued in the newly formed skin, the atrophic changes remained the same, but the hypertrophic changes had diminished. The skin was more tolerant of all forms of actinic rays. The vaseline and starch dressing was still employed at night, but the wearing of gloves during the daytime was no longer necessary.

In the primary attack, the right hand was less severely affected than the left. Tenderness extended up both arms into the axillæ.

I suffered with malaise, daily chill and fever (mild), headache, sore throat (mild), nausea and vomiting (one attack quite severe), vertigo (mild), and one attack of dyspnoæ (severe, but short), probably from cardiac impairment of function. There was a fine rash, like that of typhoid fever, scattered over the entire body.

Whether an attack of erysipelas, sustained in both hands, about twelve years previous, predisposed me to X-ray inflammation, modified its course or prevented cancerous sequelæ, I am unable to determine, certain it is the two diseases (X-ray dermatitis and erysipelas) have many symptoms in common.

SECONDARY, TERTIARY, QUARTANARY DERMATITIS.

From careful observations, made upon patients and myself, I conclude that each attack of X-ray inflammation leaves the parts more predisposed to subsequent attacks. Consequently, after several repetitions from a given volume, strength, tension and duration of exposure, the period of incubation decreases, while the inflammation developed will be more and more intense. One hand of the operator may develop dermatitis in a few days, while the other hand, which has been less frequently or less severely attacked, requires a week or more for its appearance; the former will be severely, the latter, slightly affected.

Even the different fingers of the same hand may have a different period of incubation and degree of reaction, according to their relative susceptibility. After repeated attacks, the period of incubation may be entirely wiped out, the reaction, with a sensation of warmth or stinging and an inflammation, more or less profound, taking place immediately. Conversely, a period of rest from raying, limitedly, decreases susceptibility.

WHY THE HANDS ARE SO FREQUENTLY INJURED AND WHY UPON THE DORSUM.

1. They are not protected by clothing.

2. They are usually a little nearer the tube than other portions of the body, dorsum outward.

3. It is a common practice with operators to employ the hand in front of the fluoroscope, dorsum presented to the tube, as an X-radiometer, judging by the translucency of the bones, etc., the degree of penetration of the X-light.

When the operator is right-handed, he will instinctively hold the fluoroscope in that member; consequently the left hand will, in the course of time, be more seriously injured.

The reverse is true if left-handed. When ambidextrous, both hands will be nearly equally affected.

The sequelæ of X-ray inflammation are:

1. More or less loss of integument, with its appendages, hair, hair follicles (alopecia), nails, sebaceous and sudorific glands.

2. Disfigurement of parts involved, such as hands, face and head, by scars, pits, warts, pigmentation, baldness, a shave that requires no repetition, skin diseases, etc.

Small cicatrices form at the labial commissures, drawing the angles of the mouth downward, giving the operator a sad expression of countenance. Dr. Wagner, of Chicago, suffers with disfigurement of the face. A French operator is reported to have nearly lost his nose. Clarence Daly (case to be reported in subsequent chapter) has scars upon his face and loss of hair; one entire hand and four fingers of the other have been removed. Dr. Early, of Dayton, O., has lost one finger. Dr. Kassabian has many small scars upon his face. Pigmentation has rendered his face much darker than its normal condition. A light streak separates the pigmentated portion of his features from the rear of his head, giving him somewhat the look of a person wearing a mask. A picture of his hands is shown elsewhere. Girdwood, Grubbe, Kassabian, Skinner, Price, Waite, Platt, Detwiller, and about one-third of the prominent operators and instrument dealers have hands which have been more or less severely injured. Blacker (case to be mentioned later) has gone on "the long journey to that bourne from which no traveler ere returned."

3. Chronic scaly skin diseases and other conditions of the parts result because some of those little functionaries, the sweat and oil glands that have moistened and lubricated your skin from the days of your inception are gone forever.

4. Horny papillary thickening of the ends of the fingers, beneath and around deformed nails, crowding the nails away from their matrices; horny ridges, lumps, nodules, warts, or callous in other localities. Some of these formations mark the sites formerly occupied by inflammatory mounds. Most of these formations can be softened and stripped off, but they

usually form again in the same places. Their subsequent degeneneration into cancer will be considered later.

5. Purpura hemorrhagia and punctate clots in the newly formed skin. The bleeding probably comes from the nutrient arteries of the defunct follicles.

6. Erythema, either circumscribed in small irregular spots in the skin and beneath the nails, or diffused over the entire surface.

7. Hyperæmia or anæmia, usually the former, the latter being confined to circumscribed areas.

8. Pigmentation or blanching of the tissues, either temporary or permanent. The surface may be left with a pigmented border and white center, as shown in an accompanying picture.

9. Hyperæsthesia to all forms of radiant energy and traumatism. This condition slowly decreases.

10. Increased vaso-motor activity.

11. Diminution or loss of the sense of touch in circumscribed areas. This sequel is rare.

12. Small abscesses at the roots of the teeth (rare). (See case reported at the Philadelphia meeting.)

13. Temporary decrease in sexual power.

14. Erratic or redundant growth of hair (rare).

OTHER DANGERS OF THE X-RAY OPERATOR.

Impairment of Vision—At the Chicago meeting of this society, Dr. Scott, of Kansas City, reported that he had been so afflicted, attributing the same to the Rœntgen rays. Personally, I am unable without glasses to read medium print, which I could do seven years ago, before I became an X-ray operator. I consider the X-ray more or less responsible; but the fluoroscopic and dark-room work, not to omit the hand of time, have each contributed their quota to the impairment.

Mr. Thomas A. Edison reports that the focusing power of one of his eyes has been lessened by the Rœntgen rays.

One of my X-ray colleagues has a mild form of opthalmia he believes to have been caused by the rays. Withdrawal from their influence is always followed by improvement. Drs. Kassabian and Waite have been similarly affected.

Opthalmoscopic examination of my eyes, made during an X-ray inflammatory attack, revealed a deficiency of pigment in the choroid. The pupils of my eyes were small, and there were indications of presbyopia, such as inability to focus perfectly the chrystalline lens for near and remote objects. Vision at thirty or forty feet was a little blurred and indistinct. This defect was overcome by distance glasses, but, since my recovery, such glasses are no longer required. I saw minute, bright falling bodies upon the window pane, showing irritation of the retina. The urine contained no albumin.

The Effects of the Roentgen Rays Upon the Generative Organs—When the X-ray operator has a mild but general attack of dermatitis the reproductive organs will darken. The hair over the symphysis pubis may or may not be thrown off. There will be desquamation of the scrotum and glands penis, although an investing foreskin of the penis may not be affected. The sexual power will be temporarily lost. (See report of experiments made upon the spermatozoa of rabbits, American Rœntgen Ray Society, Philadelphia.) The urine contains no albumin.

Collapsing of Crook's Tube and Cutting of Flesh by the Centrifugal Flying Fragments of Glass—This accident occurred to Dr. King, of Bradford, and was reported in the *American X-Ray Journal,* July issue of current year. The entire subject, including the danger to the eyes of the operator, has been considered by my predecessor, Dr. Pancoast.

POSSIBLE BUT NOT PROBABLE RESULTS OF OFT REPEATED AND LONG CONTINUED EXPOSURES TO THE RŒNTGEN RAYS.

At the Chicago meeting of this society, Dr. Grubbe reported that two patients whom he treated became deranged.

One of my patients developed a violent form of insanity with delusions and hallucinations; another was troubled with amnesic aphasia. Both patients had been subjected to a long course of treatment for severe forms of carcinoma, and were of the nervous temperament. Both cases terminated fatally.

Can the X-rays, like the solor rays, cause structural changes in the cerebrum, leading to derangement of the men-

tal faculties? Or do the ptomaines from cancerous disintegration some times cause so profound an auto-infection as to bring about such psychical disturbances? Should you answer my primary questions affirmatively, then it follows as a corollary that the danger to the patient is, in a measure, shared by the operator, and solaroidal effects can be anticipated.

Infection—The abraded tissues of the X-ray operator afford a fruitful culture field for infection with chronic malignant diseases with which his patients suffer. His office is thronged with patients suffering with some of the vilest forms of disease that flesh is heir to.

Cancer—In the Associated Press report of August 3, 1903, appeared the following: "One of Thomas A. Edison's X-ray operators, named Clarence Daly, who had used the X-rays for several years, is to-day a physical wreck. Cancer broke out on both arms, one of which was amputated, and four fingers of the other hand had to be removed; his face is wrinkled and his hair fallen out."

In a personal letter received from Mr. Edison, he assures me that this report is true.

I quote the following apropos from *The Electric-Therapeutic and X-ray Era,* September number, 1903: "The premature demise of an English physician from malignant disease is alleged to be traceable to an X-ray accident. Blacker suffered a severe burn on one of his fingers while manipulating the apparatus. This irritation produced an unyielding dermatitis, which rapidly ascended the arm. Cancerous disease of the skin now appeared at the elbow and evidences of malignancy were soon perceptible in the axilla; the disease finally involved the entire shoulder, the progressive character of which precluded operation."

For other cases illustrating this danger, I refer you to the current literature dealing with the subject, rather than weary you with further quotations.

In order to throw the searchlight of investigation upon one of the etiological factors of cancer, I will inquire of a patient who has that disease upon the forehead (see picture) what was the cause? She replies, the sting of a mosquito.

I ask another, suffering with epithelioma of the lips and cheek the same question (see picture). He says a cut from a barber's razor.

Still another, with osteo-carcinoma of the bones of the face (see picture), says he was struck with a stone.

A patient with one-half of his face involved fell upon a plank that cut his lip. Cancer subsequently developed in the cicatrix (see picture).

A lady with scirrhus of the breast and a matastatic focus on the face, believes the primary lesion to have been caused by falling against a bedstead (see picture).

In other words, slight injuries to epithelial tissues, in accord with the teachings of Cohnheim, the German savant, often prove a potent cause of cancer.

Is it strange, therefore, that X-ray inflammation, with its specific action upon this variety of tissue, be it physiological or pathological, should rarely cause a cancer in an operator having the cancerous diathesis by degeneration of the horny ridges, nodules, warts, cicatrices, etc., left as sequelæ, or a retrograde epithelial metamorphosis, superinduced by the inflammatory process?

Patients subjected to a course of X-ray treatment of over one year's duration, who are not thoroughly shielded from the action where not required, may become emaciated; the parts exposed have eruptions, œdematous swelling and spasmodic contraction (slight), painful or otherwise. This danger is limitedly shared by the operator.

That the rays have been accused of causing headache, indigestion and other disturbances of the stomach and bowels, sore throat and symptoms like those produced by a mild sunstroke, by different operators and writers, some of which I have previously mentioned in the context. That all of these conditions may and do exceptionally result, I have good reasons to believe.

PREVENTATIVE MEASURES.

In view of the multiple dangers that beset the X-ray operator, I have adopted the following precautions:

1. Never allow the use of any portion of my body for others to look through.

2. Never change the adjustment of a tube or position of patient while the apparatus is in operation.

3. Never use the hand in front of the fluoroscope as an X-radiometer.

4. Never allow the strong destructive rays in the center of the field to shine upon my person.

5. Wear the safety X-ray gloves, invented by Dr. Price, of Cleveland, and of this society. Silk or rubber gloves, lined with foil, are better than no protection.

6. Wear glasses as an extra protection for the eyes against the rays and the disruption of tubes.

7. Wear an office coat with extra long sleeves that come well over the backs of the hands; the skirt of coat to cover the hips; the entire garment lined with foil or the Price material.

A safety fluoroscope can be made with a hood fitted over the trunk and attached around the margin of the distal extremity, the hood to be large enough to extend over the head, face and hand of the operator. A rigid, flaring metallic plate can be fitted around the middle of the trunk of the fluoroscope on its outside, extending laterally therefrom, and a thick piece of plate glass fitted to the inside of the removable end of that instrument.

8. Not to excite the tube with a sinusoidal current, or what amounts to the same thing, overload the direct current with spark gaps, and thus change it into the sinusoidal. A tube thus excited scatters rays in nearly every direction.

9. Remain behind the target, the static machine or thick plate glass screens, having metallic bases, through the glass of which I can observe all that is transpiring, or examine my patient, who holds the fluoroscopic screen, while I remain excluded from the X-ray field.

10. If obliged to enter the field for any purpose, remain as far away from the excited tube and work in the outer confines as much as possible. Do what is required, then return to a position of safety immediately. Another good plan for self-protection is to screen yourself from such pencils of X-light as would come your way with a copper plate, placed so that

you can see the working of the other portions of the tube, or screen the entire tube and observe its reflection in a looking glass. A combination screen and tube holder, to invest the tube on all sides, with a suitable aperture for the egress of the rays, can be made of very thick glass.

The new form of clinical adjustable tables, with a copper or sheet iron covering nailed onto the wooden top, the top turned on end, make admirable impromptu screens for many purposes.

The foreign makes of tubes, said to be made of glass which is opaque to the rays, except at a limited area, are worthy of trial.

Such precautions I now scrupulously maintain, for my recent experience with this subtle force, reminds me of the words of Shakespeare, given to the ghost of the erstwhile Hamlet, King of Denmark (paraphrased):

> "My hour has almost come,
> When I, to sulphurous and tormenting flames
> Must render up myself . . .
> Doomed, for a certain term, to walk the night;
> And, for the day, confined to fast in fires,
> Till the foul . . . (unnatural condition) of
> My body is burned and purged away."

Buffalo, N. Y.

DISCUSSION.

DR. WESTON A. PRICE, Cleveland, O.: *Mr. President*—I think that there is no profession in the world that men strive more to obtain proficiency in, and for which they will more patiently undergo every hardship, than that of the poet. If the X-ray work will do for everybody what it has done for Dr. Pitkin, giving him poetic sentiments and such fluency of speech in return for his sufferings, I think many will gladly be martyrs to the cause and take the terrible course of preparation.

My own work has not been of such a nature that I have had to fear any such dire results as those mentioned by the doctor, yet I have given this subject considerable thought and study for the protection of my hands, and also to benefit a few

such unfortunates as, I understood, were having serious trouble. I tried to get an opaque flexible material that was a non-conductor, and yet efficient for this purpose. First, I took flexible rubber and placed it between two pieces of cloth, but it was not largely a non-conductor to static currents, and that was an objection. Then I went about making a rubber cloth which would have all the qualities needed; one that could be handled and even boiled, if necessary. This rubber cloth can be made into aprons to protect the stomach, or into coats and vests, or anything that might be desired. The cloth is very flexible and opaque, and does not seem to have any tendency to break down from usage. It is about as opaque as two-thirds that thickness of lead would be, which would be as opaque as four thicknesses of heavy lead foil. It is so very opaque that the rays from even the highest tube will not penetrate the heavy weights. I have had gloves made of it which do protect the hands, and rather than have such hands as some operators have, every operator should use them.

In my dental work I throw a little piece of this cloth over my exposed hand and do not use the gloves, which I use only in my experimental work.

As to the increasing tendency to be affected by the ray, I can testify to that. Four or five years ago I used to spend from one to four hours a day experimenting along various lines with my apparatus. I would work for hours before my tube without any protection whatever, of course maintaining a respectful distance, and without any apparent effect. Now, five minutes will cause more irritation than five hours would at that time. This suggests to me that we must of necessity do something to protect our bodies, for who knows but what some chronic condition may be brewing, and that at some later time will make its appearance with, perhaps, startling consequences. It is a very serious matter. It may express itself in the form of an atrophy or even a malignant growth, and I do not propose to run any such risk if there is any way of protecting myself.

I believe that it is essential to protect the entire body. So that you can appreciate the efficiency of this rubber cloth, I

have made two skiagraphs of my hands, one being covered by the cloth, and the other not. You can get an idea of the impermeability of the cloth to the X-ray.

Some time ago I fashioned this apparatus for holding my tube. It is made of a hard form of rubber containing this opaque material, so as to protect everybody from the effect of the X-rays. It is light enough to be manipulated with ease. For my larger tubes I have it go clear around the anode. I use that tube for several purposes, particularly for my pyorrhoea cases. I place the mouthpiece right between the patient's teeth; the lips are brought down and together on it, so that I can get my ray to bear directly on the affected teeth. It is a great protection, and also is useful, because with it the tube can be placed right into the mouth. It is, for all practical purposes, an absolute non-conductor. There is no tendency to spark across, and the patient is in no danger of being shocked by the current. I took that rubber cloth and placed it between the terminals of the coil, and the spark went nearly six inches, three inches down and three back, rather than to go through, showing its great insulating efficiency. We can protect our whole body in this way, and we can put a little mirror just behind the tube into which we can look to see how the tube is working. That prevents any unnecessary exposure or the entrance of any part of us into the field of activity of the tube. With these little precautions we need not incur any such terrible risks as Dr. Pitkin has described.

Cut No. 2 shows one of these shields.

Dr. James Marsh, Troy, N. Y.: I want to call your attention to a personal experience in the hope that it will serve as a warning to others. For over a year I have had considerable trouble with my feet. I have always been careful to keep behind my tube, but when the treatment had been begun I would take a chair and sit down at the table, with my feet under it. In this way, although my body was protected, my feet were placed in the path of the rays. The result is that I have lost the skin of the soles of my feet and of all my toes about forty times, and I assure you that the torture is most exquisite. Dr. Pitkin's description is a very mild one compared with what I have suffered with my feet. The tops of the feet also were

affected, but not so much as the soles. I have often observed that the effect of the X-ray manifests itself first on the under surface, instead of the upper. I do not know the reason for this, but I know that it has occurred in my own case and in many others.

DR. W. W. JOHNSON: I had a case of tuberculosis of the knee joint, in which a burn occurred after treatment on the side opposite to the one that was being exposed to the ray.

PROF. GOODSPEED: I think that action is due to the secondary effect to which I referred yesterday. The entire room and everything in it is rendered negatively active during the action of the tube, and, possibly, it remains so for hours afterward. I have had some experience of my own which would indicate that that is true. I believe that you cannot account for these occurrences in any other way.

DR. CHAS. L. LEONARD, Philadelphia: I wish to thank Dr. Pitkin for discussing his own case in such a liberal way for our benefit, and for pointing out the dangers which may arise. I have been suffering from X-ray burns for some time, and I have been putting in some time in the endeavor to find some way of preventing these accidents, and also to make it possible for me to recover. My hands were in very bad shape, and I also had trouble with my feet similar to that mentioned by Dr. Marsh, although I did not expose them to the rays, as he did. I have found that relief has resulted, not from protecting either my person or my hands, but from covering the tube in such a way that the rays are not carried out into the room. This eliminates not only the immediate radiance emanating from the tube, but also the danger from the secondary radiance coming from the rooms and objects in it.

I have been using of late a very simple form of protection, and it answers every purpose. It consists of a pasteboard box covered with lead to the extent that it protects the operator entirely from the lateral discharge of rays from the tube. The bottom of the box has a large window in it, the size of which can be regulated by the lead foil encircling the box. I have produced rectangular burns on my patients, showing the efficiency of this contrivance. The smaller areas are covered by

a small sheet of the same lead, and you have here not only a protection for your patient and for yourself, but also an easy method for giving treatment without inconveniencing the patient; at the same time a more rapid method of adjusting the tube to the area which is to be treated. This is a very important subject, one which should receive careful consideration as to what might happen to the operator, and how he can protect himself.

In addition to knowing how to protect ourselves, it is necessary for us to know how we can cure ourselves. We all have used some kind of treatment, and I think we ought to tell each other just what we have done, so that these various remedies that have been used may be tried by others, perhaps with some success. I have found that the use of superfatted soaps, containing resorcin have been valuable in softening the skin of my hands; so has the inunction of the hands with lanolin containing a small amount of boric acid. Under that treatment my hands have healed very nicely, and to-night I have the pleasure of knowing that an ulcer that has existed on my finger for about six months, has healed. That ulcer has been extremely painful, keeping me awake for hours night after night, and yet it was not an inch in diameter. I had almost given up hope that it ever would heal. I made a hard rubber shield to protect it from injury and anointed it with lanolin and boric acid, and I have at last succeeded in healing it up. After you have had such an experience as that you will do all you can to be careful; and what one may suffer, another may suffer, and, therefore, this warning is given.

Dr. Mihran K. Kassabian, Philadelphia: Most of us have been burned by the X-rays when using the fluoroscope for indefinite periods, this being especially due to bringing the hand so near to the tube. Of course, to-day we are not making as many fluoroscopic examinations as formerly, so that to-day a smaller number of burns occur in this way. We take everything on the plate and are far away from the tube. An irritant of electrical energy is constantly coming from the larger coils, which increases the severity of the burns with which we are already suffering. In order to lessen this danger to a minimum degree I have placed my induction coil on a shelf fastened

to the wall near the ceiling, on top of static machine. The interrupter is retained in a position near the floor, where I can regulate it easily.

By placing the tube in the box I demonstrated yesterday, in conection with my paper, both the operator and patient are protected from injury. Some operators desire to see the color of the rays or the radiance of the platinum. For that reason I have devised a reflector attached to the tube by a horizontal rod, in order that you may see the rays coming from the tube.

In order to effect a cure of my hands I have used every remedial agent mentioned in all the text-boks on skin diseases and also every patent medicine which has come to me by mail otherwise from time to time. I would use one for two or three days, then throw it away and try another, but nothing seemed to me any good. Every physician I have met from time to time kindly gave me some advice or a prescription that he wanted me to try, but without success. I would like to have some of you discuss the matter of treating burns of our hands, because it is very vital with us. Still, I have been unfortunate in finding a remedy to cure my hands. I hope that we will soon be able to prevent these injuries and find a specific remedy, so beginners will not have the same misfortune.

Dr. Louis A. Duhring, Philadelphia: I have listened with pleasure to both the interesting paper and the discussion that followed. In the paper I was particularly struck by the great diversity of the symptoms and lessons described. My own experience with these so-called burns has been limited chiefly to the hands of acquaintances and others, who have consulted me from time to time, requesting that I do something to relieve them. I have always been struck by the fact that the changes that take place in the skin, as the result of the effect of the X-ray, are different from those of any of the known skin diseases. So much so, that when cases of this kind have been brought to my attention, I would remark, even before the patient said anything about the nature of his ailment, "This is not a common disease of the skin, but is either some rare disease or one due to some external agency." Whereupon it would be stated that it was caused by the X-ray.

The inflammation that is produced (and it was only yesterday that I saw a remarkably inflammatory case of the kind), is distinctly peculiar, not only as regards the lesions, but its course. Thus, I have never seen a case of X-ray dermatitis that simulated eczema, the commonest skin disease. Any one could differentiate between these two, and this is singular, for the reason that eczema, as every one knows, is a distinctly multiform disease, and yet the inflammation from the X-ray seldom takes on an eczematous form; nor have I ever seen it assume a form resembling psoriasis. It is even more multiform than eczema, and that point has been brought out very well by Dr. Pitkin.

As to the treatment of these cases, when chronic, my experience has been unsatisfactory, like the experience of others, and, I think, for the reason that we are dealing with a very peculiar condition of the integument. My impression is, based on the experience I have had in this work, that the impression made by the X-ray on the skin, affects, first, the nerves, and, second, the arterioles; and a condition results analogous to certain other well-known and rare chronic diseases of the skin, in which the lesions may be almost as manifold as in X-ray dermatitis. Take, for instance, that rare disease, morphoea, which is characterized by very varied lesions, and which is dependent upon a trophoneurosis. It is well established that in morphœa we have distinct changes in the arterioles of the skin, which give rise to trophic secondary, as well as to the primary lesions. I believe, as stated, that the inflammation produced by the X-ray is due to an impression, first on the nerves and, secondly, on the arteries. This is the reason why treatment in that disease is so unsatisfactory. I have used all kinds of remedies, and I doubt if I could mention any that you have not used. I know of none better than the remedies which would be used for neurotic eczematous conditions in the same stage.

It behooves us all to be cautious in the use of the X-ray, and thus to prevent such accidents. I think the tendency is to try for too rapid results.

Dr. Wm. C. Egelhoff, Chicago: After listening to the remarks of Dr. Pitkin, I am reminded of some symptoms that

I had about a year ago. At that time I seriously considered taking a vacation, for I was certain that my stomach and bowels were being affected by the X-ray. I became more miserable every day in spite of the fact that I was paying considerable attention to my condition, in the hope that I would find something that would relieve the trouble. Finally, I concluded to complete the work, since my symptoms did not tally with any known disease. So I examined my stools, and you can imagine my surprise when I found that I was suffering from a tape worm. But, in place of removing the tape worm at once, I studied my disease and found that the symptoms that I had experienced were entirely different from those reported in the text-books. So I continued to study my case for about two months. I dieted myself, changing the diet every now and then, but I grew steadily worse, and I came to the conclusion that it would be well for me to part company with my friend, the tape worm. I took the remedy prescribed for that condition, and as soon as I was rid of the worm, I began to feel better, and have not had any trouble with my stomach or bowels since.

In regard to the protection of the hands, I will say that within about a year and a half I was so unfortunate as to lose three sets of finger nails and my hands have scaled at least seven times. I, too, used all the remedies that I could think of, but with the same result as mentioned by others, until I, at last, found one which seemingly gave me very good results. The treatment at bed time consists in washing the hands with water as hot as could be borne, using plenty of green soap and the hand brush. Of course, that made the hands feel very sore and tender, and very painful at first, but I continued to do this, and it improved my hands very much. After this washing I anointed the hands with plenty of olive oil, and then put on a pair of kid gloves. Under that treatment my hands improved wonderfully.

Dr. Fairfax Irwin, U. S. P. H. and M. H. S., Philadelphia: I would like to mention the results of treatment of X-ray burns. I have treated some four or five cases of burns on the leg, and it seemed to me that no matter what application was

made, I could see no change for the better. Most of the burns were caused by X-ray treatment or an attempted diagnosis. One case, a very large ulcer of the thigh, the largest and deepest ulcer I have ever seen, was treated in the wards of the hospital where I was on duty for four or five months without any improvement. Finally it occurred to me that possibly, if the ulcer was protected from the light, and the leg kept absolutely quiet, it might heal. So I had a wire cage made, placed a loose gauze bandage over the ulcer, so as to permit of circulation, fastened the leg in the cage, and, much to my surprise, the ulcer healed in about two weeks, after remaining unhealed for five months. I had the same experience with an ulcer of the arm.

Of course, these two cases are not enough to count upon, and I simply mention them for what they may be worth.

DR. LEAVITT E. CUSTER, Dayton, O.: While the doctor's paper was very poetic, yet it was full of truth. He pointed out the fact very forcibly that the X-ray effects are cumulative, and we, as X-ray operators, are becoming more and more susceptible to the influence of the ray. As we continue in our work we must bear in mind that we are becoming more susceptible, and that there is more need for being cautious every day in order to save ourselves much trouble in the future.

DR. PITKIN (closing the discussion): With regard to the relation of the different tubes and the degree of penetration of the rays they are capable of generating, valuable information can be obtained by a study of the color markings upon the concavity of the cathode cup. When the circular spot is large, light blue, transparent with a play of colors at the outer border, the tube is of the high variety.

In medium tubes, instead of the light blue center, it will be of a darker shade of blue, less transparent and smaller in size. In the softer varieties of tubes I find either that the central spot is of a golden hue or a very minute dark central spot, having a red border. In other words, the size of the circular central spot on the cathode cup increases with use and the degree of penetration of its rays. Thus, by inspection of the cathode cup of any of my tubes, I can tell what degree of pen-

etration the tube will render me. The cathodal spectrum, or play of colors, extends from the center outward with use, its size being proportionate to the amount of service that a given tube has seen. If, when you return to your homes you will take the pains to look at the cathode cups of your tubes and watch the changes of colors there depicted you will find the statements just made corroborated by actual observation.

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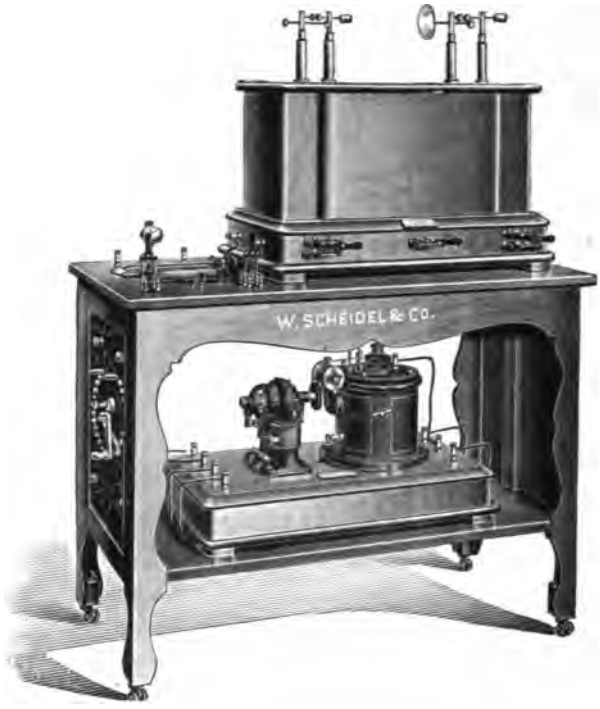

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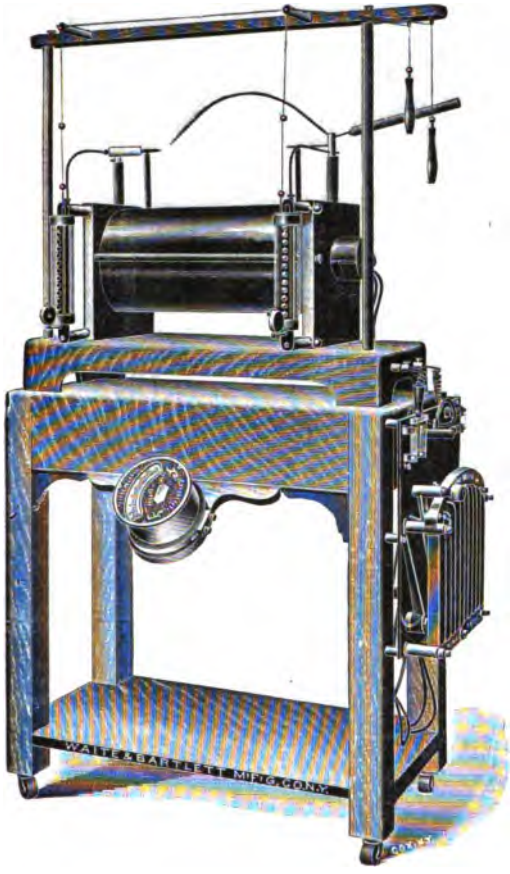

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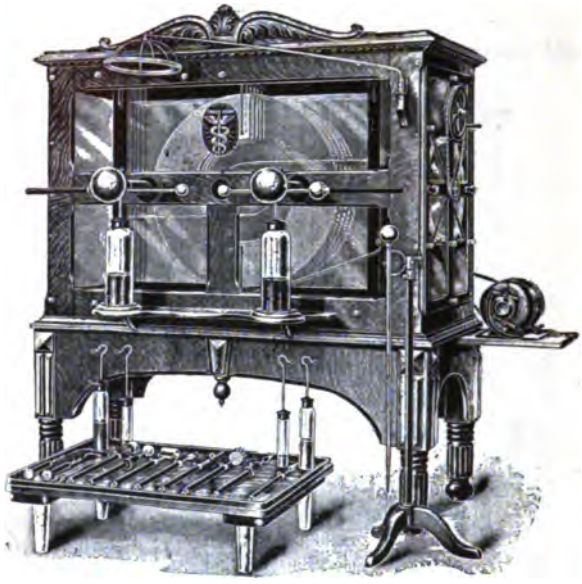

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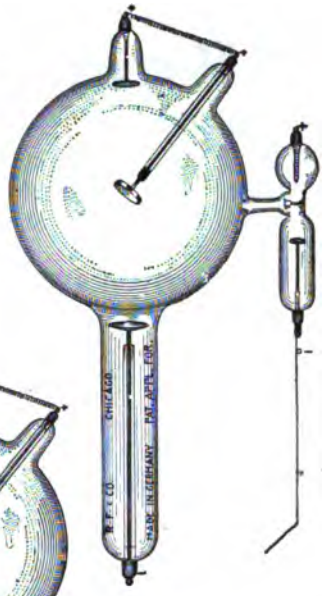

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